RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 71 DECEMBER 1958 No. 6

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Vol. 71 DECEMBER 1958 No. 6

The Significance of Postoperative Pneumoperitoneum in Infants and Children[1]

JOHN W. HOPE, M.D.,[2] and HARRY R. CRAMER, M.D.[3]

POSTOPERATIVE pneumoperitoneum is a normal finding in the adult. References to free air left behind in the peritoneal cavity of these older patients following laparotomy (1, 2, 3) occur in the literature, but the authors have been unable to find any mention of this problem with specific reference to infants and children.

It is generally agreed that air in the peritoneal cavity of an adult following laparotomy will persist for seven to fourteen days, and it has been reported as late as twenty-three days. It was in 1952 that the problem was first encountered in an infant by one of the authors. An eight-day-old male infant was transferred to the Children's Hospital of Philadelphia because of vomiting bloody, bile-stained fluid since birth. On admission, the baby was extremely dehydrated and almost dead. Roentgen examination of the abdomen (Fig. 1) revealed a mechanical obstruction of the small bowel, most probably in the ileum. Laparotomy confirmed the roentgen finding of obstruction due to an ileal atresia about 8 inches proximal to the ileocecal valve. Following resection and an end-to-side anastomosis, the baby did remarkably well, and it was thought that he would probably survive in spite of the long delay before treatment. On the fourth postoperative day the abdomen became somewhat distended, and roentgen examination (Fig. 2) revealed a rather severe degree of pneumoperitoneum. Considerable discussion ensued, and finally, on the basis of adult standards, it was decided not to operate. The following day the abdomen was even more distended, and roentgen examination revealed slightly more air in the peritoneal cavity. Laparotomy was again performed; a leak was found at the site of the anastomosis and a severe peritonitis was present. Death occurred five days later. Obviously the pneumoperitoneum was not a normal postoperative finding.

Two years later, in 1954, a similar problem arose, and again observance of adult standards led to a mistake in diagnosis. A four-week-old female infant was admitted because of rapid enlargement of the head since birth. A diagnosis of a communicating hydrocephalus was made and a subarachnoid-peritoneal shunt was performed. Three days postoperatively the abdomen became distended. Roentgen examination revealed a pneumoperitoneum (Fig. 3, A). Again it was presumed that

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TABLE I: FREQUENCY OF PNEUMOPERITONEUM IN INFANTS AND CHILDREN FOLLOWING LAPAROTOMY

Case	Age	Sex	Operation	Time of Roentgen Examination Following Surgery	Presence or Absence of Pneumoperitoneum
1	8 mo.	M	Nephrectomy and ureterectomy (transperitoneal)	28 hr.	No air
2	5 mo.	M	Reduction of intussusception	26 hr.	No air
3	2 day	M	Abdomino-perineal pull-through for imperforate anus	24 hr.	No air
4	4½ yr.	F	Excision of Wilms tumor	24 hr.	No air
5	3 wk.	M	Pyloromyotomy	24 hr.	No air
6	5 mo.	F	Subarachnoid-peritoneal shunt	23 hr.	No air
7	3 mo.	F	Small bowel resection	18 hr.	No air
8	3 wk.	M	Pyloromyotomy	9 hr.	No air
9	5 days	M	Duodeno-jejunostomy	8 hr.	No air
10	4 mo.	F	Closure of jejuno-ileostomy	6½ hr.	No air
11	4 mo.	M	Nephrectomy and ureterectomy (transperitoneal)	5 hr.	No air
12	6 yr.	M	Appendectomy	1 hr.	No air
13	3 yr.	M	Abdomino-perineal pull-through for megacolon	1 hr.	No air
14	5 yr.	M	Operative cholangiogram and exploration of extrahepatic ducts	1 hr.	No air
15	7 mo.	M	Substernal colon transplant for esophageal atresia	1 hr.	Trace of air
				24 hr.	No air
16	8 yr.	M	Appendectomy	30 min.	No air
17	2 yr.	M	Inguinal herniorrhaphy	30 min.	No air
18	3 days	M	Removal of huge multicystic kidney (transperitoneal)	30 min.	Trace of air
				6 hr.	No air
19	3½ mo.	F	Abdominal exploration and repair of patent urachus	30 min.	Trace of air
				8 hr.	Less air
				24 hr.	No air

this free air represented the normal pneumoperitoneum expected in the adult following laparotomy. The following day the abdomen was even more distended. Roentgen examination (Fig. 3, B) showed about the same amount of free air in the abdomen, but now with fluid in the peritoneal cavity as well. At laparotomy a perforation was found in the small bowel. This defect was closed, and with supportive treatment the baby recovered.

By a strange coincidence, the week following this second case, a telephone call was received from Dr. Roy Greening of the Department of Radiology of the Hospital of the University of Pennsylvania, who was at that time in the U. S. Navy, stationed in Norfolk, Virginia. Dr. Greening's question was, "How long does a pneumoperitoneum persist in an infant following a laparotomy?" The question was raised because of the death, at the Norfolk Naval Hospital, of a baby who, at two days of age, had been operated upon for an ileal atresia. On the second postoperative day the abdomen had become slightly distended and a roentgen examination revealed a moderate pneumoperitoneum. In this case too, a decision had been reached not to operate because a postoperative pneumoperitoneum was supposedly a normal finding. The following day the distention had increased and roentgen examination revealed considerable fluid in addition to the air. Operation revealed leakage from the anastomosis and death ensued from peritonitis.

In attempting to evaluate the problem of postoperative pneumoperitoneum, the first approach was examination of the abdomen in infants and children twenty-four hours following a laparotomy. Most of the cases examined were deliberately chosen because the operative procedure was complicated, lengthy, and frequently involved the removal of a large mass lesion. We were greatly surprised to find no air in the peritoneal cavity in any of these infants and children at twenty-four hours. Gradually the postoperative examination was reduced to a film taken in the recovery room within thirty minutes following surgery.

A total of 19 infants and children were examined (Table I). In only 3 of the patients examined within thirty minutes

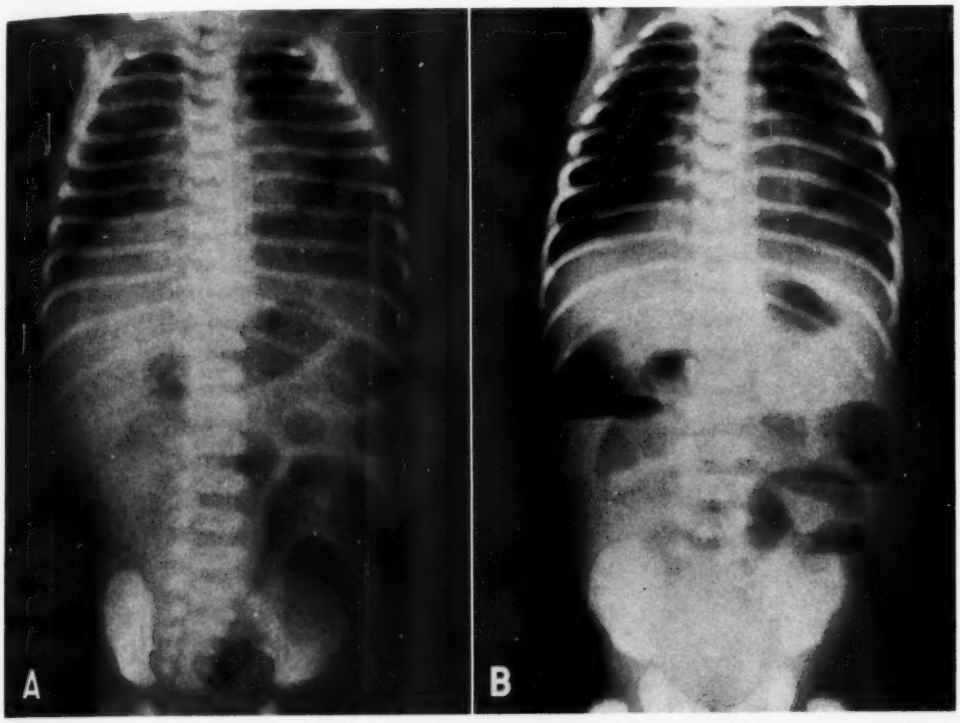

Fig. 1. An eight-day-old male admitted because of vomiting bloody, bile-stained fluid since birth. Supine (A) and erect (B) films of the abdomen reveal a mechanical small bowel obstruction most probably in the ileum. Laparotomy confirmed the diagnosis of ileal atresia.

postoperatively was there any air present in the peritoneal cavity, and in each of these cases the air was not visualized at twenty-four hours. Figure 4, A shows one of the largest mass lesions in the series. It proved to be a huge multicystic right kidney, which was removed transperitoneally. Figure 4, B shows the minimal amount of air present in the peritoneal cavity thirty minutes after closing the abdomen. Air was not present at twenty-four hours.

Having failed to find any evidence of a pneumoperitoneum lasting more than twenty-four hours, the next question to be answered was the adequacy of our method of examination. Dr. C. Everett Koop, Surgeon-in-Chief of The Children's Hospital of Philadelphia, helped solve this problem. Following routine herniorrhaphy, he injected a known quantity of air into the peritoneal cavity just

Fig. 2. Erect film of the baby shown in Fig. 1, taken on the fourth postoperative day, reveals a rather extensive pneumoperitoneum. This was thought to be a normal postoperative pneumoperitoneum, but proved to be due to a leak at the anastomotic site.

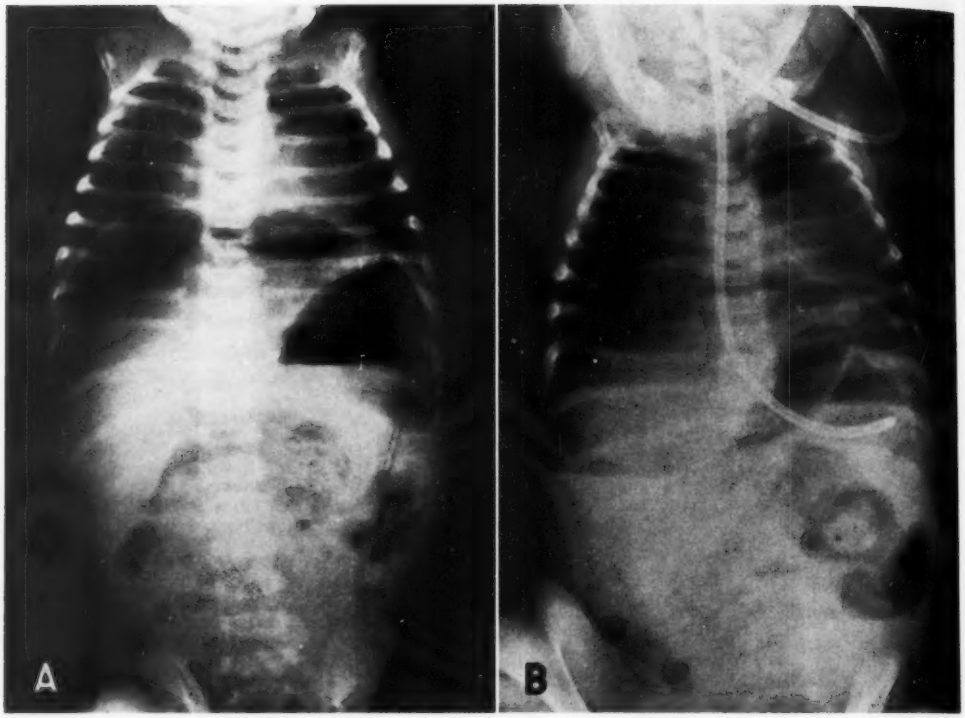

Fig. 3. A four-week-old female admitted because of hydrocephalus. A subarachnoid-peritoneal shunt was performed. A. Erect film taken on the third postoperative day, showing a rather extensive pneumoperitoneum. B. Erect film taken on the fourth postoperative day showing about the same amount of free air, though now there is a fluid level within the peritoneal cavity.

At a second laparotomy a perforation was found in the small bowel.

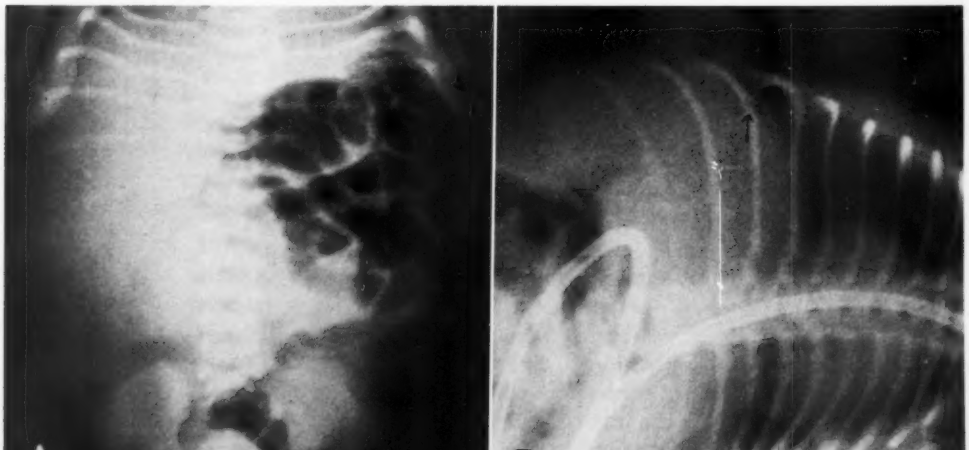

Fig. 4. A three-day-old male admitted because of an abdominal mass. A. Supine film of the abdomen, showing a huge mass occupying the entire right side of the abdomen and the left lower quadrant. All of the bowel has been displaced into the left upper quadrant. This proved at laparotomy to be a huge multicystic right kidney. B. Left horizontal decubitus film taken thirty minutes after laparotomy, showing a minute trace of air in the peritoneal cavity (arrow).

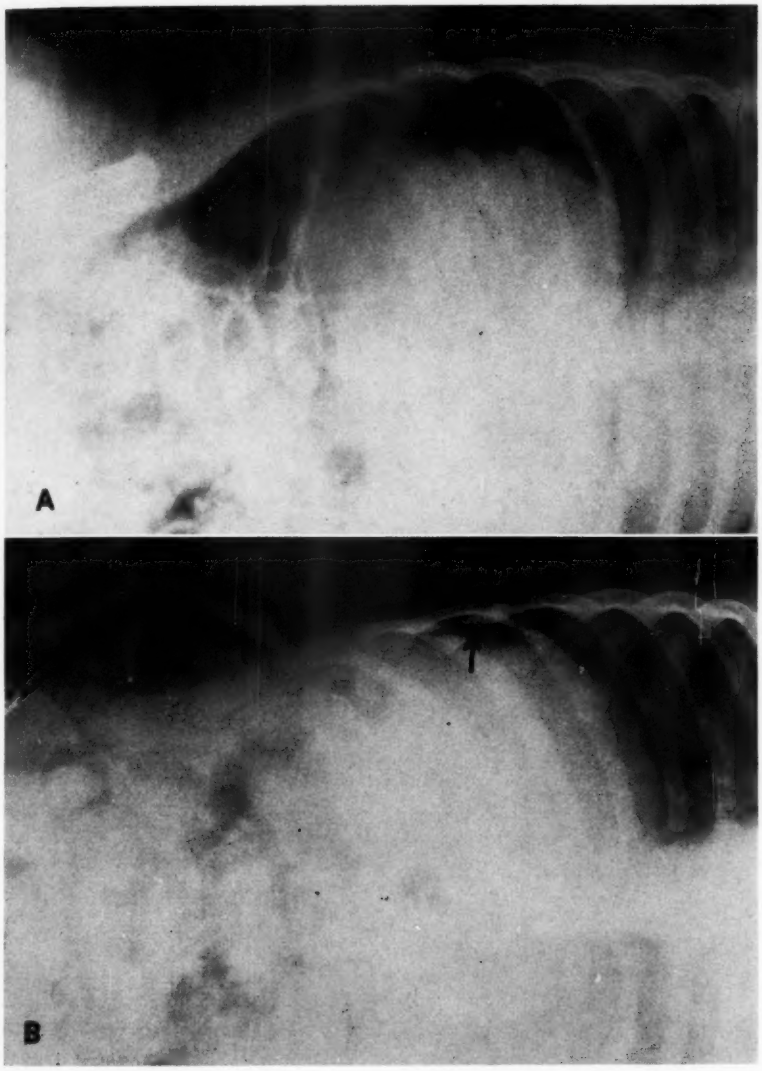

Fig. 5. A nine-month-old male in whom 110 c.c. of air were injected into the peritoneal cavity following a herniorrhaphy. A. Left horizontal decubitus film taken thirty minutes after laparotomy, showing an extensive pneumoperitoneum. B. Left horizontal decubitus film eighteen hours after laparotomy, showing very little free air remaining in the peritoneal cavity. At twenty-four hours all the air was absorbed.

prior to final closure of the peritoneum. His first case was that of a nine-month-old male in whom 110 c.c. of air was injected. Figure 5, A is a film taken thirty minutes later, showing considerable free air in the peritoneal cavity. Figure 5, B shows the amount remaining at eighteen hours. By twenty-four hours all the air was absorbed.

Dr. Koop's second case was that of a four-year-old male in whom 100 c.c. of air was injected. Figure 6, A is a film taken one hour postoperatively, showing considerable free air in the peritoneal

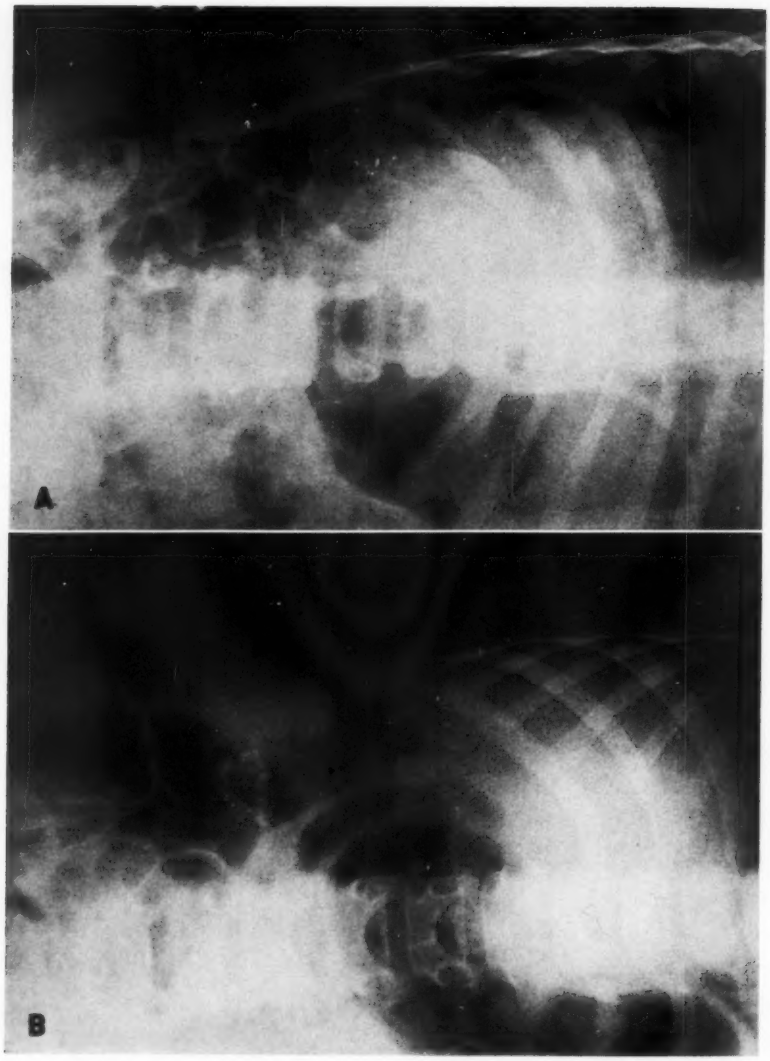

Fig. 6. A four-year-old male in whom 100 c.c. of air were injected into the peritoneal cavity following a herniorrhaphy. A. Left horizontal decubitus film taken one hour postoperative, showing considerable free air in the peritoneal cavity. B. Left horizontal decubitus film at fifty-four hours, at which time the air was all absorbed.

cavity. At twenty-four hours a moderate amount of air was still present and at forty-eight hours a trace of air could still be seen. At fifty-four hours the air was gone (Fig. 6, B).

From these 2 cases it became apparent that 100 c.c. of air in the peritoneal cavity, even at four years of age, is a very appreciable quantity and easily visualized. The amount of air introduced was then reduced to 50 c.c. The Philadelphia U. S. Naval Hospital co-operated with us in this study and Figure 7, A shows one of their cases. It is a film of a four-year-old male taken immediately following the injection of 50 c.c. of air. Figure 7, B shows the amount of air remaining at twenty-four hours. There

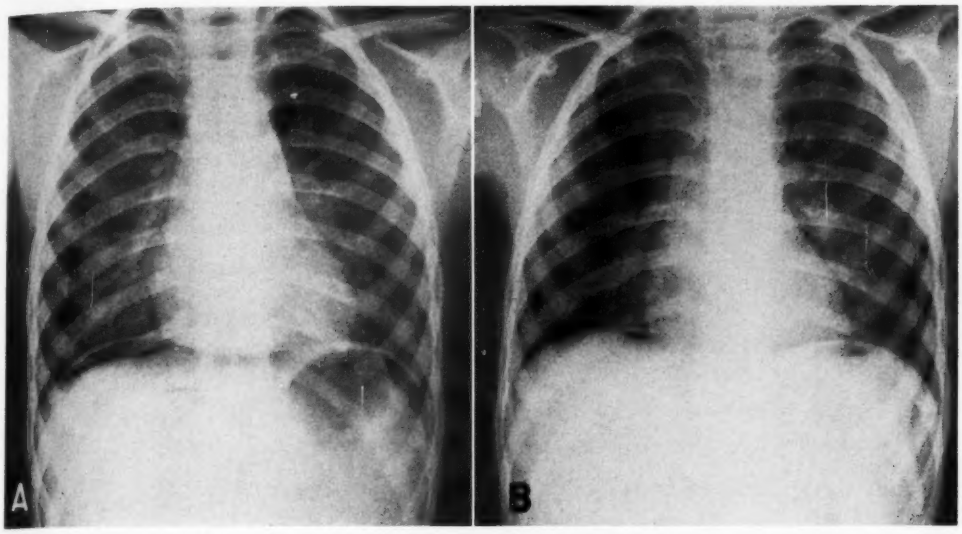

Fig. 7. A four-year-old male in whom 50 c.c. of air were injected into the peritoneal cavity following a herniorrhaphy. A. Erect film taken thirty minutes postoperative, showing a moderate pneumoperitoneum. B. Erect film taken twenty-four hours postoperative; a trace of air is still present. No air was present at forty-eight hours. (This case is from the Philadelphia U. S. Naval Hospital.)

was no air present at forty-eight hours.

Finally, the amount of air injected was reduced to 10 c.c. Figure 8, A is a film of an eight-year-old female taken thirty minutes following the injection of that amount of air. Even this small quantity in an eight-year-old is easily visualized. Figure 8, B, taken at seven hours, shows no air.

Table II presents a summary of observations on the 12 infants and children in whom air was experimentally injected. At forty-eight hours the air was gone from 9 of the 12, and in the other 3 only a minimal trace remained.

TABLE II: DURATION OF EXPERIMENTALLY PRODUCED PNEUMOPERITONEUM

Case	Age	Sex	Amount of Air Injected (c.c.)	Time of Disappearance of Pneumoperitoneum
1	4 yr.	M	100	54 hr.
2	9 mo.	M	110	24 hr.
3	5 yr.	F	50	10 hr.
4	4 yr.	M	50	48 hr.
5	5 yr.	M	50	Trace at 48 hr.
6	5 yr.	M	50	Trace at 48 hr.
7	3 yr.	M	50	48 hr.
8	2 yr.	F	25	33 hr.
9	6½ yr.	F	10	18 hr.
10	6 yr.	M	10	8 hr.
11	8 yr.	F	10	7 hr.
12	8 wk.	M	10	8 hr.

DISCUSSION

The problem of a pneumoperitoneum following a laparotomy has not arisen again in The Children's Hospital of Philadelphia since 1954, so that obviously it is not a common one. However, on three known occasions, dependence on adult standards led to delay in surgery, resulting in perhaps two unnecessary deaths.

Our series of 19 infants and children studied following laparotomy is not large, but the findings are so constant as to appear significant. The absence of air at twenty-four hours certainly is very different from the usual finding in adults. The ages varied from two days to eight years, and in this range no difference due to age was noted. At what age an older child will present the usual adult finding is not yet known.

Seldom will a roentgen examination of the abdomen be ordered earlier than forty-eight hours following laparotomy. If more than a trace of air is present at

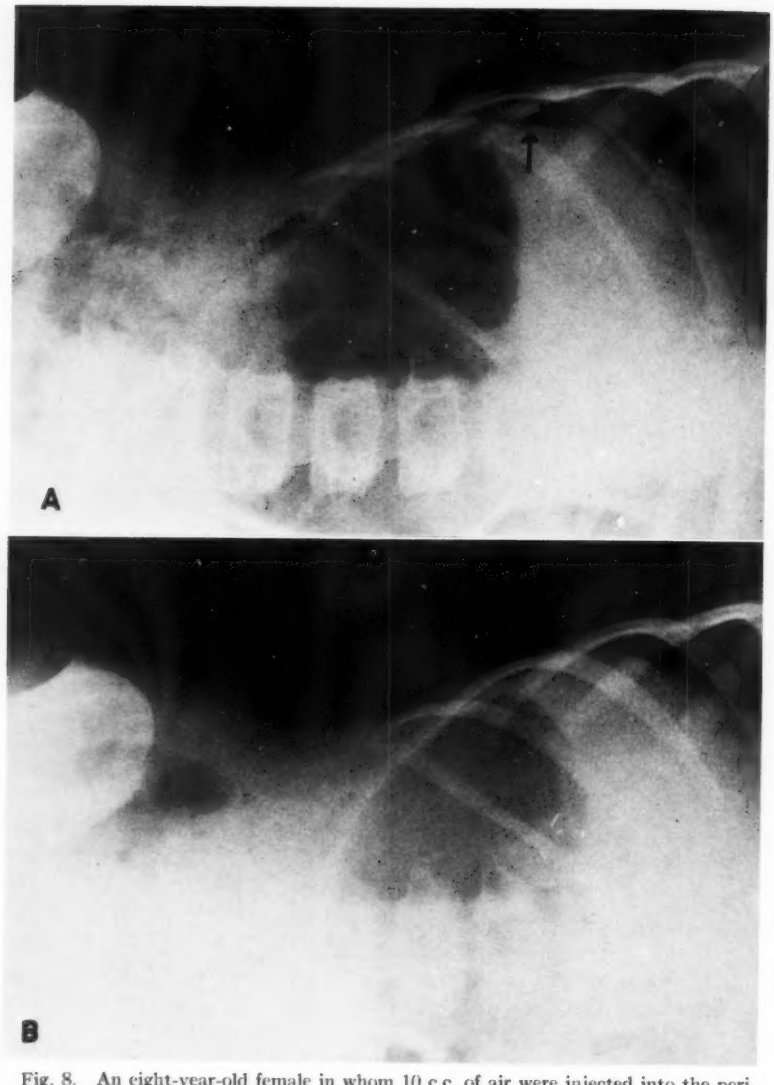

Fig. 8. An eight-year-old female in whom 10 c.c. of air were injected into the peritoneal cavity following a herniorrhaphy. A. Left horizontal decubitus film taken thirty minutes postoperative, showing a small pneumoperitoneum (arrow). B. Left horizontal decubitus film taken seven hours postoperative; the air is no longer visualized.

this time, a perforation is the most probable cause.

Air injected experimentally into the peritoneal cavity of infants and children is absorbed rapidly. Even as little as 10 c.c. can be visualized in an eight-year-old child. In several of the experimental cases, films were exposed in both the erect and the left horizontal decubitus positions. In each position as little as 10 c.c. of air was visualized.

SUMMARY

1. No air was visualized in the peritoneal cavity of 19 infants and children twenty-four hours following laparotomy.

2. Seven of the 19 patients were examined at one hour or less following

surgery, and only 3 of these showed a trace of air which was not visualized at twenty-four hours.

3. As little as 10 c.c of air experimentally injected into the peritoneal cavity of infants and children can be demonstrated by either an erect or a left horizontal decubitus film.

4. Any appreciable quantity of air in the peritoneal cavity twenty-four hours after operation should arouse suspicion of a continuing leak, and a second laparotomy is probably indicated.

NOTE: Special acknowledgment is made to the Department of Radiology of the Philadelphia U. S. Naval Hospital for contributing to the experimental work in this study.

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Philadelphia 46, Penna.

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SUMMARIO IN INTERLINGUA

Le Signification De Pneumoperitoneo Post-Operatori In Infantes E Juveniles

Es generalmente accordate que aere in le cavitate peritonee de un adulto subjicite a laparotomia persiste inter septe e dececinque dies e que iste phenomeno pote esser reguardate como normal. Post vider 3 casos de infantes ubi le application de ille standard de adultos esseva responsabile pro un retardo in le decision de intervenir chirurgicamente, in 2 del 3 con consequentias mortal, le autores effectuava un studio de 19 patientes pediatric qui habeva essite subjicite a laparotomia, e in nulle de iste casos succedeva illes a visualisar aere in le cavitate peritonee vinti-quatro horas post le operation. Septe individuos del mesme gruppo habeva etiam essite examinate un hora o minus post le operation, e solmente 3 monstrava a ille tempore un tracea de aere le qual, nonobstante, esseva non plus visualisabile al fin de vinti-quatro horas.

Pro investigar le problema additionalmente e pro testar le adequatia del methodo de examine usate in ille casos, cognoscite quantitates de aere esseva introducite in le cavitate peritonee in un numero de juvene patientes immediatemente ante le reclausion del peritoneo al conclusion de un herniorrhaphia routinari, e subsequentemente roentgenographias eseva obtenite a varie intervallos. Esseva constatate que un quantitate de solmente 10 cm^3 de aere assi injicite pote esser demonstrate roentgenographicamente in position erecte o decubital, in le secunde caso per exposition sinistro-horizontal.

Omne notabile quantitate de aere in le cavitate peritonee de un juvene patiente pediatric vinti-quatro horas post le operation deberea inspirar le suspicion de un perfluxo persistente e suggerer le necessitate de un repetition del laparotomia.

Operative Cholangiography in the Diagnosis of Prolonged Jaundice in Infancy[1]

JOHN H. HARRIS, JR., M.D.,[2] A. EDWARD O'HARA, M.D.,[3] and C. EVERETT KOOP, M.D., Sc.D. (Med.)[4]

MANY CONTRIBUTIONS have appeared in the recent roentgenologic literature relative to operative cholangiography, and in many institutions it is a routine procedure during adult biliary tract surgery. In contrast, there has been no mention of the usefulness of delineating the biliary ductal system in similar circumstances arising in pediatric surgery. A review of the nonradiologic literature disclosed but two articles specifically pertaining to the application of operative cholangiography in infancy (18, 23). Several other authors mention the procedure as being of value in elucidating the etiology of obstructive jaundice in infants and in facilitating the pending surgical procedure (5–8).

The purpose of this paper is to describe the technic of operative cholangiography that has been used at The Children's Hospital of Philadelphia, to illustrate the roentgen findings in the normal infant biliary ductal system (Figs. 1, 2, 3, and 5), to present illustrative cases of the more commonly encountered types of extrahepatic biliary atresias (Figs. 4, 6, 7, and 8), and to discuss briefly the problem of jaundice in the newborn with special reference to the obstructive type.

Hsia *et al.* (10), in a review of 156 cases of obstructive jaundice in infancy seen at the Children's Medical Center of Boston, reported that 60 per cent were caused by biliary atresia. A similar review by Gerrish and Cole (4) revealed congenital atresia of the bile ducts to be the etiologic factor in 61 per cent of 41 cases of surgical jaundice in infants and children. In 1954, Redo (16) reviewed 300 cases of congenital atresia of the extrahepatic bile ducts from the literature and added to these 27 cases. This anomaly can therefore no longer be considered a medical curiosity. In fact, it is the commonest cause of obstructive jaundice in infancy. Holmes, as early as 1916 (9), suggested that certain types of biliary atresia were amenable to surgical correction. Since that time, many different operative procedures have been advocated. The percentage of extrahepatic biliary atresias amenable to surgical correction has been variously reported as being from 18 to 37 per cent (5, 11, 15, 16). Some of these estimates, however, are based on small series, and it is our belief that figures higher than 20 per cent are unrealistic.

Surgery of the biliary passages is frequently difficult in adults. In infants and children, because of the size of the biliary ducts, the technical difficulties are increased. Furthermore, needless surgery in the region of the bile ducts is to be avoided, if at all possible, because of subsequent cicatricial complications. The role of the roentgenologist in surgical jaundice in infants and children therefore assumes considerable importance. If the biliary tree can be shown to be normal, exploration is not justified. On the other hand, it is of definite value to the surgeon if the site and nature of an atresia can be demonstrated prior to exploration of the hepatoduodenal ligament.

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[1] From The Departments of Radiology and Surgery, The Children's Hospital of Philadelphia, and The Harrison Department of Surgical Research, School of Medicine, University of Pennsylvania. Presented as part of a Pediatric Panel at the Forty-Third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

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TECHNIC

The peritoneal cavity is entered through a small right subcostal incision and the gallbladder is identified. Its appearance frequently gives a clue to the underlying pathology. If it is of normal size and contains normal appearing bile, a patent communication between the gallbladder and the liver may be assumed, but this in

Fig. 1. Cholangiogram demonstrating the normal caliber and configuration of the biliary ductal system in a three-year-old child. The patient was admitted with a history of abdominal pain and hematemesis, but no history of jaundice. At laparotomy acute cholecystitis, duodenitis, and pancreatitis were found.

no way reflects the caliber of the communication. Further, this does not aid in the differentiation between the "inspissated bile syndrome," viral hepatitis, and atresia of the common bile duct. A mushroom catheter is inserted into the gallbladder through a small cholecystostomy, and held in place with a purse-string suture. After irrigation of the biliary ductal system with saline to eliminate artefacts caused by bile plugs (Fig. 5, Case 3), 8 to 20 c.c. of 15 per cent Urokon is injected through the catheter. The actual amount of the contrast material is dependent upon the size of the gall-

Fig. 2. Cholangiogram illustrating the normal biliary ductal system in a child of five months. The examination was performed because of persistent jaundice since birth. The infant's mother had been jaundiced during the second trimester of pregnancy. A liver biopsy was reported as showing chronic hepatitis, and the child died at the age of ten months after developing all the signs of liver failure.

bladder. It is important that the patient be apneic during the time of the x-ray exposure, and that the exposure be made after approximately 80 to 85 per cent of the contrast medium has been introduced. We attempt to obtain a right posterior oblique projection in order to avoid superimposition of the ductal structures and to project them away from the spinal column.

If the cholangiographic findings indicate a normal biliary ductal system with free flow of the contrast medium into the duodenum (Figs. 1 and 2), a liver biopsy is taken and the abdomen is closed. If, on the other hand, there is roentgen evidence of atresia of the ductal system, the initial incision is extended to allow adequate exposure for exploration of the porta of the liver.

Naturally, an atretic gallbladder precludes an operative cholangiogram. Retrograde injection of the common bile duct by way of a transduodenal approach

Fig. 3. Case I. Normal operative cholangiogram in a patient found to have infectious hepatitis. The gallbladder is moderately large for an eighteen-month old infant, but the biliary ductal system is of normal caliber.

has been done by Hicken (8), but in his experience this procedure has been attended by a high mortality.

CASE HISTORIES

CASE I: W. S., an 18-month-old colored male, was admitted to The Children's Hospital of Philadelphia with a history of jaundice for the preceding seven months, associated with dark urine, bulky, frothy light yellow stools, and pruritus.

The patient had been previously admitted to another hospital with the same clinical findings, at which time he was found to have hepatomegaly and elevation of the serum bilirubin and serum alkaline phosphatase. A laparotomy was performed and the bile ducts were found to beno rmal, with normal appearing bile in the common bile duct. A liver biopsy was reported as "normal." Following discharge, the jaundice persisted, although varying in intensity.

Physical examination at the present admission showed a thin, irritable, icteric child with a protuberant abdomen. The liver margin was palpated 4 to 5 cm. below the right costal margin and was smooth, firm, and nontender. The laboratory studies, except for the presence of bile in the urine, were all normal. Intravenous and oral cholecystography failed to demonstrate the presence of contrast medium in the biliary system. Because of the clinical findings, it was felt that there was an incomplete obstruction of the common bile duct. A laparotomy was performed twenty-one days after admission. The gallbladder was moderately large and thin-walled, and contained normal appearing bile. An operative cholangiogram (Fig. 3) demonstrated a normal biliary ductal system. A liver biopsy was taken and the abdomen was closed.

The patient was discharged one month later with the diagnosis of infectious hepatitis. When last seen in follow-up, nine months following his admission, he was normal and physical examination was negative.

Fig. 4. Case II. Typical cholangiographic findings in a patient with atresia of the common hepatic duct. Note the reflux of the contrast medium into the duct of Wirsung, and its relationship to the gastric air bubble.

CASE II: M. L. B., an 11-month-old-white girl, was admitted to The Children's Hospital of Philadelphia on May 31, 1956, with a history of jaundice since the age of three weeks. The jaundice, which had not altered in intensity until two weeks prior to admission, had been associated with dark orange urine and clay-colored stools. Two weeks prior to admission, the jaundice deepened noticeably. At the time of admission, the patient appeared chronically ill, was obviously jaundiced, and was found to have hepatosplenomegaly, ascites, and distended veins on the anterior abdominal wall. The significant laboratory findings included alkaline phosphatase of 20.1 Bodansky units, total serum bilirubin of 15 mg. per cent, normal serum protein with reversal of the A/G ratio, 4+ cephalin flocculation, and thymol turbidity of 4.9 units. The urine contained bilirubin and there were no bile pigments in the stool. Direct and indirect Coombs' tests were negative. During this hospital admission an upper respiratory infection developed which was relatively unresponsive to therapy. Consequently the patient was discharged without either liver biopsy or laparotomy.

On readmission, two months later, the jaundice was found to have persisted and there had been pro-

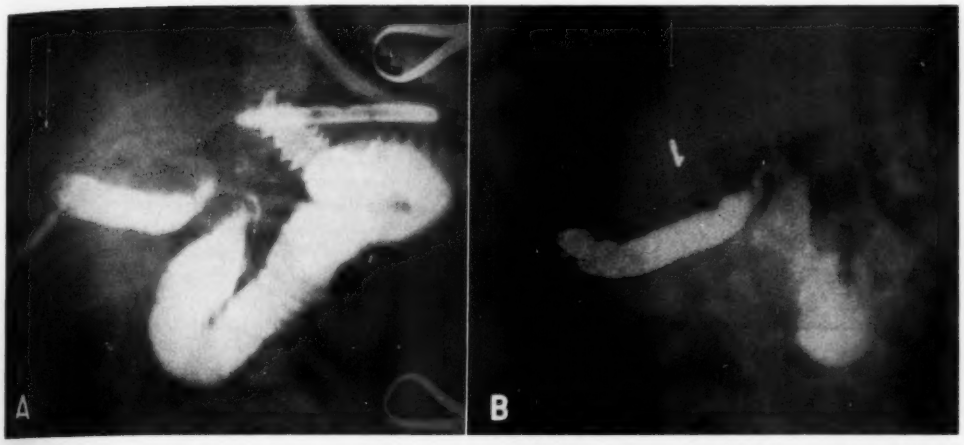

Fig. 5. Case III. A. Operative cholangiogram demonstrating a normal gallbladder, cystic duct, and common bile duct. None of the contrast medium is present in the common hepatic duct. B. Cholangiogram carried out ten days postoperatively, showing the presence of contrast medium in the common hepatic duct. The liver biopsy revealed hepatitis.

gression of ascites and the development of pitting edema of both legs to the knee. An exploratory laparotomy was performed on July 17, 1956, at which time an operative cholangiogram was obtained (Fig. 4). Twenty cubic centimeters of 15 per cent Urokon were injected into the biliary system through a mushroom catheter placed in the fundus of the gallbladder. The gallbladder and the cystic and common ducts were visualized and found normal. There was free flow of the contrast medium into the duodenum. A normal pancreatic duct was demonstrated. The common hepatic duct and its branches were not visualized. The study was interpreted as indicating atresia of the extrahepatic bile ducts. No ducts leading from the liver hilus to the junction of the cystic and common ducts could be identified when the hepatoduodenal ligament was explored. A liver biopsy was taken and the abdomen closed. The biopsy material was reported as showing biliary cirrhosis (juvenile type) secondary to congenital atresia of the major hepatic ducts.

CASE III: V. C., a 4-month-old colored female, was admitted to The Children's Hospital of Philadelphia on Jan. 14, 1956, because of jaundice which had appeared at the age of two and a quarter months. This had been associated with dark urine and clay-colored stools. On admission, the patient was poorly developed and appeared undernourished. She was obviously icteric. Many superficial veins were visible over the protuberant abdomen, and the liver margin was palpable 4 to 5 cm. below the right costal margin. The hemoglobin was 8.5 gm. There were 14,300 white blood cells with 49 per cent neutrophils and 49 per cent lymphocytes. The urine was positive for bile and negative for urobilinogen. Two stool specimens were negative for bile pigments. The total serum proteins were 7.2 gm., with a reversal of the A/G ratio. Total serum bilirubin was 10.3 mg. per cent, and the cephalin flocculation test was 4+.

At laparotomy, nine days following admission, a small collapsed gallbladder containing a little clear, yellow bile was found. Operative cholangiography (Fig. 5, A) demonstrated contrast medium in the gallbladder, the cystic and common ducts, and the duodenum. None was seen in the common hepatic duct. A liver biopsy was obtained and the abdomen closed. Ten days postoperatively, the cholangiogram was repeated through the cholecystostomy tube (Fig. 5, B). This examination outlined the common hepatic duct, although no contrast medium was present in the hepatic radicals. Histologic study of the biopsy material demonstrated "hepatitis," and the patient was discharged on the twelfth postoperative day. Two months following discharge, she had gained weight, appeared more alert, and her jaundice had cleared noticeably. The total serum bilurubin was 8.4 mg. per cent. Five months later, the total serum bilirubin had risen to 12.3 mg. per cent and the thymol turbidity was 6 units. The child was markedly icteric and showed definite evidence of growth failure and mental retardation.

CASE IV: E. S., a 17-month-old white girl, was admitted to The Children's Hospital of Philadelphia with a history of recurrent jaundice since birth. The last episode of icterus began at nine months of age and became progressively more severe. Each episode had been associated with dark urine and light-colored stools. There was no history of association with jaundiced individuals, nor had the patient or her mother received or given blood. Except for the clinically obvious jaundice and moderate hepatosplenomegaly, the physical examination was nega-

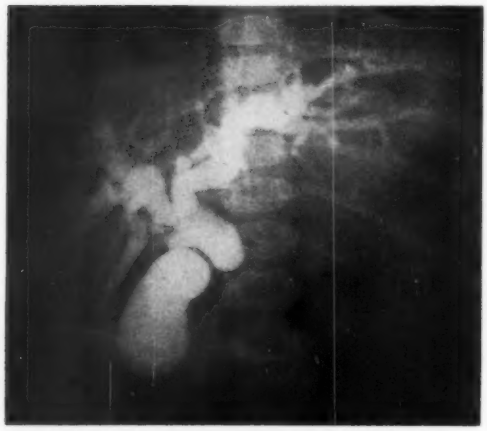

Fig. 6. Case IV. Operative cholangiogram of a seventeen-month-old white female with atresia of the common bile duct. There are moderate dilatation of the gallbladder and marked dilatation of the common hepatic duct and its radicals. No contrast medium is seen in the common bile duct distal to the junction of the cystic and common hepatic ducts.

tive. Growth and development were normal. The routine laboratory studies were negative. The urine was positive for bile but not for urobilinogen. Stools were negative for the presence of bile pigments. Total serum bilirubin was 19.1 mg. per cent; total proteins were 7.5 gm., with reversal of the A/G ratio, and the thymol turbidity was 6 units.

An intravenous cholecystogram failed to demonstrate any of the contrast medium in the biliary system. At laparotomy the gallbladder was found to be markedly dilated and to contain normal appearing bile. An operative cholangiogram (Fig. 6) demonstrated dilatation of the gallbladder and of the cystic duct. The hepatic duct and its radicals were similarly dilated. None of the contrast medium was seen to pass distal to the junction of the cystic and common hepatic ducts.

On the basis of the roentgen demonstration of atresia of the common bile duct, the tip of the gallbladder was excised and a cholecystojejunostomy en Roux-Y was performed. A liver biopsy was reported as showing "findings compatible with biliary cirrhosis of the liver due to obstruction." The patient made an uneventful recovery and was discharged twelve days postoperatively with marked improvement in the degree of jaundice.

EMBRYOGENESIS OF THE BILIARY SYSTEM

The primordium of the hepatic diverticulum, a ventral outgrowth of the gut entoderm, is present in 3-mm. embryos, and from this develop the liver, gallbladder, and the biliary ductal system. The superior portion of the diverticulum gives rise to the glandular tissue and the intrahepatic bile ducts, while the inferior portion becomes the extrahepatic ductal system. An evagination from the inferior portion becomes the gallbladder and the cystic duct. The distal portion of the hepatic diverticulum elongates into the hepatic and common bile ducts. During

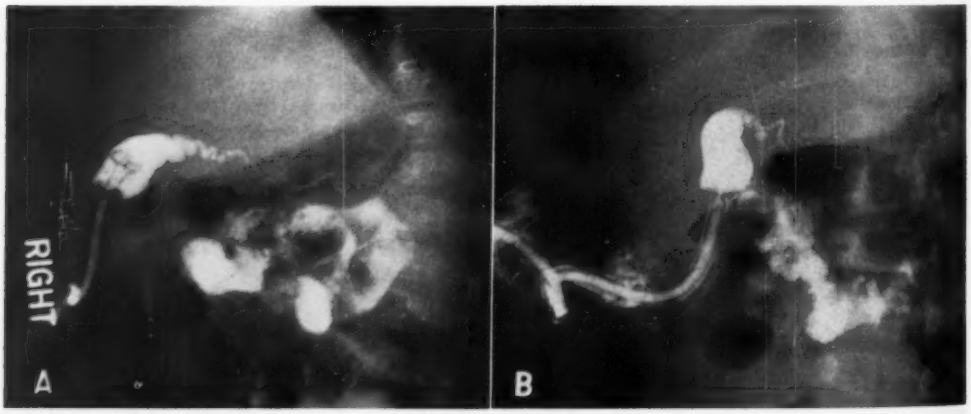

Fig. 7. A. Operative cholangiogram of a ten-week-old white male with persistent jaundice since the second day of life. No contrast medium is present in the common hepatic duct, and the common bile duct is of smaller caliber than normal.

B. Postoperative cholangiogram carried out with the patient in the Trendelenburg position, confirming the operative cholangiographic findings. The initial impression of atresia of the common hepatic duct and hypoplasia of the common bile duct is substantiated. At laparotomy no ducts could be found from the liver hilus to the junction of the cystic and common bile ducts. When last seen, one year postoperatively, the patient had intense jaundice, ascites, and hepatosplenomegaly.

the seventh week, because of rotation of the gut, the ductal system shifts from its ventral position to the adult dorsal location. In the course of the eighth week the intrahepatic bile ducts arise by dichotomy as branches from the common hepatic duct.

The gallbladder arises from the caudal region of the hepatic diverticulum. In the 5-mm. embryo, it is a solid epithelial cylinder that is carried away from the duodenum by the elongating common duct. Further elongation of the gallbladder primordium results in differentiation into the gallbladder and the cystic duct. The lumen of the gallbladder and the cystic duct does not appear until the seventh week.

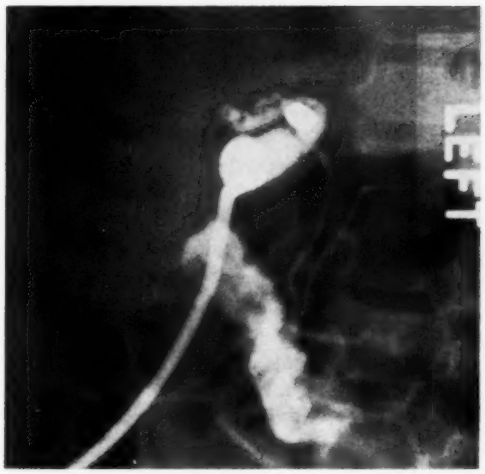

Fig. 8. Operative cholangiogram of a three-month-old colored female with persistent jaundice since the age of three days. The gallbladder, the cystic duct, the common bile duct, and the main pancreatic duct are outlined. Contrast medium is seen in the duodenum. This represents atresia of the common hepatic duct.

THEORIES REGARDING THE ETIOLOGY OF BILIARY ATRESIA

Many theories have been promulgated concerning the etiology of atresia of the bile ducts. Some regard it as a congenital and others as an acquired condition. In 1913, Yllpo (24) first suggested that congenital atresia could be explained by an arrest of growth of the bile ducts during that phase of their development when they are represented by solid cords. This concept has been widely accepted and was reiterated by Ladd (12) in 1935. Arey, in his text *Developmental Anatomy*, endorses this postulate (2).

Rolleston and Hayne (17), in 1901, were the first to speculate that atresia might be acquired. They reported a case of congenital hepatic cirrhosis with obliterative cholangitis and proposed the theory that the obstruction of the bile passages was caused by fibrosis secondary to the inflammatory reaction. It was their thought that "toxins," either fetal or maternal (the latter by crossing the placental barrier), produced an intrauterine hepatitis with subsequent descending cholangitis. Current work by Stokes *et al.* (22) and Hsia *et al.* (10) tends to substantiate this early philosophy. Each of these groups of investigators is convinced that the virus of homologous serum hepatitis in the mother can cross the placenta, causing intrauterine hepatitis in the embryo or fetus. Stokes *et al.* reported a case in point in which a mother who had no history of liver disease gave birth to a child in whom jaundice developed at the age of two months. A biopsy of the infant's liver, at this time, disclosed marked fibrosis and the child died at the age of eighteen months with advanced cirrhosis. Injection of blood from this mother and her child induced homologous serum hepatitis in human volunteers.

Scott *et al.* (20) reported jaundice resembling biliary atresia developing in 3 of 5 siblings during the neonatal period. All 3 died before the age of nine months. In each, the histologic study of biopsy material obtained at laparotomy demonstrated characteristic findings of viral hepatitis. One of the 3 proved to have atresia of the extrahepatic bile ducts. The mother and her second and third children, although clinically normal, were found to have elevated cephalin flocculation tests. These authors assumed a chronic carrier state of homologous serum hepatitis in the mother and transplacental infection of all

her children. It was believed that the two living progeny, who were never clinically jaundiced, had subclinical hepatitis with subsequent recovery. Further, Scott attempts to draw an analogy between the etiology of the atretic bile ducts in one of the children who died and the effects that the rubella virus has on an embryo.

In 1945, Skelton and Tovey (21) postulated two forms of biliary obstruction associated with icterus gravis. The first, in their opinion, was caused by blockage of one of the main hepatic ducts with inspissated bile plugs, and the second was the result of conversion of the bile ducts into fibrous cords. A year later, Lightwood and Bodian (14) reviewed this work and, in addition, 8 cases of atresia of the bile ducts seen at the Hospital for Sick Children, Great Ormond Street, London. In none of these cases was there laboratory evidence to support a diagnosis of erythroblastosis fetalis. They therefore concluded that there was no causal relationship between icterus gravis neonatorum and congenital atresia of the bile ducts. They were in agreement, however, with the proposal that bile stones could develop on the basis of inspissated bile plugs and thereby obstruct the flow of bile into the duodenum. Hsia, in the series referred to previously, found that 15 per cent of his 156 cases of prolonged obstructive jaundice were caused by inspissated bile secondary to erythroblastosis fetalis. In our opinion, at least some of the cases listed in the literature as "inspissated bile syndrome" were cases of hepatitis in which jaundice disappeared sometime following irrigation of the extrahepatic biliary system with saline. Because of the sequence of events, a causal relationship was postulated.

DIFFERENTIAL DIAGNOSIS OF PROLONGED JAUNDICE IN INFANCY

Included among the causes of jaundice of the newborn and infants are icterus neonatorum, congenital hemolytic jaundice, erythroblastosis fetalis, syphilitic hepatitis, jaundice due to sepsis, intrauterine viral hepatitis, and congenital atresia of the bile ducts.

Icterus neonatorum is a physiologic finding caused by the rapid destruction of red blood cells during the first week of life. The jaundice is usually self-limited and rarely lasts more than seven to fourteen days. Liver function tests are normal and bilirubin is present in the stools but not in the urine. Congenital hemolytic jaundice can be readily diagnosed by increased fragility of the red blood cells. Congenital syphilitic hepatitis can be diagnosed by serologic tests for syphilis, roentgen examination of the long bones, and the various stigmata found on physical examination. Tests for blood group incompatibilities and the Coombs' test for Rh incompatibility aid in the diagnosis of erythroblastosis fetalis. The jaundice associated with sepsis can be identified by fever, leukocytosis, and a positive blood culture. The organisms most commonly isolated are the hemolytic streptococcus and the colon bacillus (5).

Differentiation between congenital atresia of the bile ducts, viral hepatitis, and the inspissated bile syndrome frequently cannot be established by means of clinical and laboratory studies. It is in these cases, in which laparotomy must be resorted to, that operative cholangiography plays an important role. It should be pointed out, however, that the decision to submit the patient to surgical exploration is not without considerable risk. It has been clearly demonstrated that patients with viral hepatitis withstand surgical procedures poorly (7, 10, 19). Harris *et al.* (7) advise postponing laparotomy until the age of four months because the jaundice due to viral hepatitis may persist for that length of time. On the other hand, the surgical consensus seems to be that exploration should be performed between the fourth and eighth weeks of life (5, 11, 15, 16). It is believed that postponement beyond this age permits irreparable fibrotic changes to take place in the liver in cases of extrahepatic biliary atresia (12, 15).

DISCUSSION

Operative cholangiography has been employed in 12 instances at The Children's Hospital of Philadelphia since 1953. Three children were one month of age, the oldest was twenty-one months, and the average age was eight months. Of the 12 patients, 6 were found to have normal extrahepatic ductal systems, 1 had atresia of the common bile duct (Fig. 6), and 4 had congenital atresia of the hepatic ducts (Figs. 4, 7, and 9). In all but one instance, operative cholangiography correctly demonstrated the state of the biliary ductal system prior to exploration of the hepatoduodenal ligament. In Case III, no contrast medium was seen in the common hepatic duct or its radicals (Fig. 5, A) and the roentgenogram was interpreted as representing atresia of this portion of the ductal system. However, when the cholecystostomy was done, normal bile was found in the gallbladder, and because of this the roentgen findings were considered to be falsely indicative of biliary atresia. A cholangiogram done five days postoperatively (Fig. 5, B) through the cholecystostomy tube demonstrated contrast medium in the hepatic and common bile ducts. The liver biopsy, taken at the time of laparotomy, was reported as hepatitis.

In each of the other 11 cases, the operative cholangiographic findings were of definite aid to the surgeon. Where a normal biliary tree was outlined, the abdomen was closed and no attempt was made to explore the region of the common or hepatic ducts. The surgical procedure was thereby shortened, reducing both the surgical trauma and the exposure of the already embarrassed liver to anesthetic agents. In addition, since only the gallbladder was involved in the surgical dissection, the possibility of postoperative fibrosis about the normal infantile ducts was entirely avoided.

In those instances where an atresia was demonstrated, the site of obstruction was identified, thereby facilitating the exploration and limiting it to the site of involvement in the hepatoduodenal ligament. In addition, the surgeon was cognizant of the type of anastomosis that would be required prior to undertaking the corrective procedure.

Case III, in which no contrast medium was found in the hepatic ductal system at the time of surgery, but in which the extrahepatic ducts proved to be patent in a postoperative examination, emphasizes three fundamentals of operative cholangiography. First, the biliary system must be well irrigated with saline prior to introduction of the contrast medium, since jaundice secondary to inspissated bile, in otherwise normal biliary ducts, is indistinguishable, both clinically and from the laboratory standpoint, from jaundice caused by atresia of the bile ducts. Inspissated bile plugs can usually be washed out with adequate irrigation and, when these have been responsible for the jaundice, a normal biliary ductal system will be outlined on the cholangiogram. Second, the presence of normal bile in the gallbladder indicates that there must be a patent communication between the liver and the gallbladder. It is no indication, however, of the caliber of the channels, nor does it exclude atresia of the common bile duct. Third, the case illustrates the value of postoperative cholangiography. It is not inconceivable that, in spite of diligent efforts at irrigation, inspissated bile plugs may remain within the ductal system. Under these circumstances, when normal bile is present in the gallbladder and the operative cholangiogram seems to indicate atresia of the common hepatic duct or its radicals, it is well simply to take a biopsy of the liver and close the abdomen, leaving the cholecystostomy tube in place (Fig. 5, A). At an appropriate later time, a repeat roentgen examination through the cholecystostomy tube will either confirm or disprove the initial findings (Fig. 5, B and Fig. 7, B). These results, interpreted in the light of the liver biopsy, should indicate the true diagnosis and the necessary remedial measures.

PROGNOSIS

Uncorrected atresia of the bile ducts, either intra- or extrahepatic, is not compatible with long life, although many patients survive for some years. Early in the course of the disease, the children usually do not appear sick. As has been emphasized, the early clinical picture is that of a jaundiced child with dark urine and acholic stools (5, 8, 15, 19). Apart from these characteristics, the child appears well nourished and well developed, eats and sleeps well, and is normal in growth and development. With time, abdominal protuberance and hepatomegaly invariably develop. Secondary to the ensuing biliary cirrhosis, the natural history of the disease leads to portal hypertension, ascites, esophageal varices, prominent abdominal venous channels and splenomegaly. Impaired liver function leads to disturbed physiology of the clotting mechanism, and there is a decrease in the total serum proteins associated with a reversal of the A/G ratio. As a rule, the serum bilirubin levels in the patients with atresia are lower than in patients with hepatitis. Even in atresia, fluctuations in levels are to be expected, and the total does not progressively rise, as might be anticipated.

There is a distinct difference in the longevity of the patients with intrahepatic biliary atresia as opposed to those with atretic extrahepatic ducts (15, 19). Children with extrahepatic atresia rarely survive the second year, although Finlayson (3) has reported one such case with survival of three years and three months. The early demise of these patients is postulated to be caused by extensive proliferation of the portal biliary epithelium leading to the rapid formation of hepatic fibrosis and cirrhosis. Moore (15) states that portal fibrosis in cases of extrahepatic atresia is well established by the age of six weeks.

With intrahepatic biliary atresia, there are portal biliary epithelial cells, but these do not form ducts. There is associated condensation of the portal stroma. Histologic examination of the liver shows very slight parenchymal change and it is believed that the slow progression of such involvement is chiefly responsible for the increased longevity of children with intrahepatic atresia (1). Sass-Kortsak, *et al.* (19) report one such patient who lived to the age of ten years.

The prognosis for those patients found to have surgically amenable types of atresia is dependent upon the site of the atresia and the age at the time of exploration. It has been mentioned that a bypassing procedure when the patient is between the ages of four and six weeks interrupts the fibrotic changes in the liver before they become irreparable. With atresia in the common bile duct the prognosis is better than when the atresia is close to the liver hilus. The percentage of survivals following surgical diversion of the flow of bile has been reported as being from 44 to 83 per cent (5, 12, 13). Gross (5) had one such patient who is alive and well, free of jaundice, at the age of twenty-four years.

SUMMARY

The place of operative cholangiography in obstructive jaundice in infants has been emphasized and the technic employed at The Children's Hospital of Philadelphia has been described in detail. A brief discussion of jaundice of the newborn and infants, with special emphasis upon congenital biliary atresia, has been presented, together with a review of the embryology of the biliary ductal system and the theories of etiology of biliary atresia. Attention has been focused upon recent work tending to implicate the virus of homologous serum hepatitis in acquired biliary atresia.

The fact that biliary atresia is the most frequently encountered cause of obstructive jaundice in infancy, that in its unaltered course the disease is fatal, and that only early surgical correction can prevent the cirrhotic process in suitable cases, emphasizes the importance of early limited exploration and study of the biliary ductal system by operative cholangiography.

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SUMMARIO IN INTERLINGUA

Cholangiographia Operatori in Le Diagnose De Prolongate Jalnessa De Infantes

Le factos que atresia biliari es le plus frequentemente incontrate causa de jalnessa obstructive in infantes, que le morbo in su curso non-alterate es mortal, e que le precoce correction chirurgic pote prevenir in appropriate casos le disveloppamento del processo cirrhotic sublinea le importantia del prompte effectuation de un exploration limitate e de studios del systema del vias biliari per medio de cholangiographia operatori.

Es describite le technica in uso in iste manovra al Hospital Pediatric de Philadelphia. Su empleo es reportate in 12 patientes de etates de inter un e vinti-un menses. In omne iste casos, con un exception, le stato del systema del vias biliari esseva correctemente diagnosticate per iste medio. Le determination del sito del natura de un atresia ante le exploration chirurgic va esser de adjuta definite pro le chirurgo mesme. Del altere latere, si le manovra demonstra que le stato del vias biliari es normal, le exploration operatori non es justificate.

Quatro casos illustratori es reportate.

Fibrocystic Disease of the Pancreas: Roentgen Manifestations

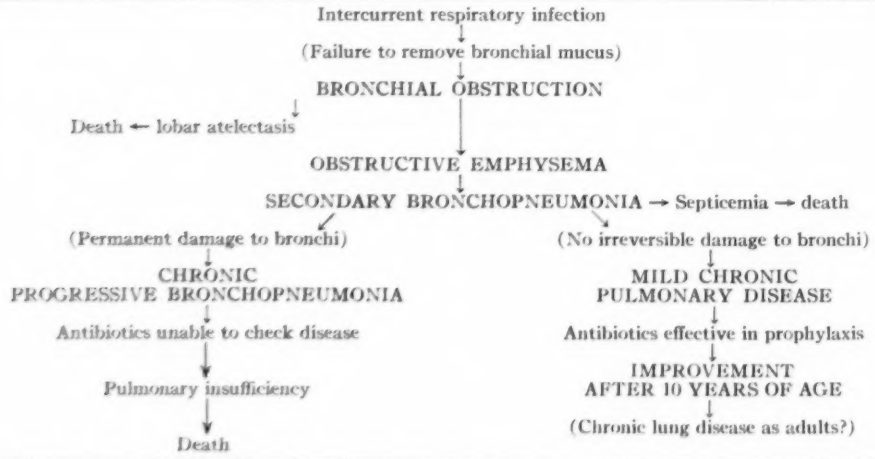
HARVEY WHITE, M.D.

FIBROCYSTIC disease of the pancreas is a hereditary, generalized, glandular disease of children manifested by pancreatic deficiency, chronic pulmonary lesions, disturbances of the sweat and salivary excretion, and cirrhosis of the liver. Involvement may be multiple or single. The condition is limited almost entirely to the Caucasian race; it is rarely found in Negroes and never in Mongolians. Though the name suggests a primary disease of the pancreas, this is misleading, since almost all of the exocrine glands are involved. Common usage, however, precludes any change in nomenclature at this time. Fibrosis of the pancreas is, in any event, an outstanding pathologic finding.

Fibrocystic disease of the pancreas occurs about once in 600 live births (1), which means that, out of a total of approximately 4,200,000 live births in the United States in a year, there are 7,000 cases. The Babies Hospital in New York sees about 27 new cases a year and at the Children's Memorial Hospital in Chicago we had 30 cases in 1956. It is thus apparent that the condition is not rare and that general radi-

Fig. 1. Prominent finger prints of a patient with fibrocystic disease (top set of four) in contrast to normal prints (bottom set of four). Imprints are on an agar plate of silver nitrate and potassium chromate.

TABLE I: RESPIRATORY INVOLVEMENT IN CYSTIC FIBROSIS OF THE PANCREAS*



* Steps that are not proved are in parentheses. From di Sant' Agnese (4).

[1] From the Children's Memorial Hospital, Chicago, Ill. Presented as part of a Pediatric Panel at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

Fig. 2. Supine roentgenogram of abdomen of newborn child with meconium ileus. Distended loops of bowel plus multiple small collections of gas mixed with meconium in right abdomen.
Fig. 3. Upright roentgenogram of abdomen of newborn with meconium ileus. Distended loops of small bowel; no fluid levels.

ologists can expect to encounter several cases a year, or more, depending on the extent of their pediatric practice. In view of the more accurate methods of diagnosis and prolongation of life by antibiotics, the disease will be seen more commonly in later childhood and also, probably, in young adults. This makes it most important for the general radiologist to comprehend fully its natural course and its roentgen manifestations.

In this presentation, we can dispense with any extensive discussion of the sweat glands, salivary glands, and the liver, and concentrate on the effects of abnormal mucus in the bronchi and pancreatic secretions.

The deficiency of pancreatic enzymes and alteration of the mucoprotein in the duodenal secretion result in an abnormally thick, tenacious meconium in the newborn (2, 3), and 10 per cent of the babies with this condition will have acute intestinal obstruction. The clinical manifestations are chronic diarrhea, foul fatty stools, and general impairment of nutrition.

In the lungs, undoubtedly due to altered mucoprotein, the secretions are thick and tenacious, leading to poor pulmonary drainage with subsequent intrabronchial obstruction and ultimate development of atelectasis, emphysema, bronchopneumonia, cor pulmonale, and death. Ninety per cent of deaths in fibrocystic disease are the result of chronic pulmonary involvement (4).

The severity of the pulmonary incapacity depends on the age of onset (the earlier, the poorer the prognosis), degree of intrabronchial obstruction, extent and control of the superimposed *Staphylococcus aureus* infection and the fibrosis of the lung. From this underlying pathology, the radiologist can expect to see pneumonitis, atelectasis, emphysema, bronchiectasis, and fibrosis. These may be minimal or extensive, depending on the severity of the disease.

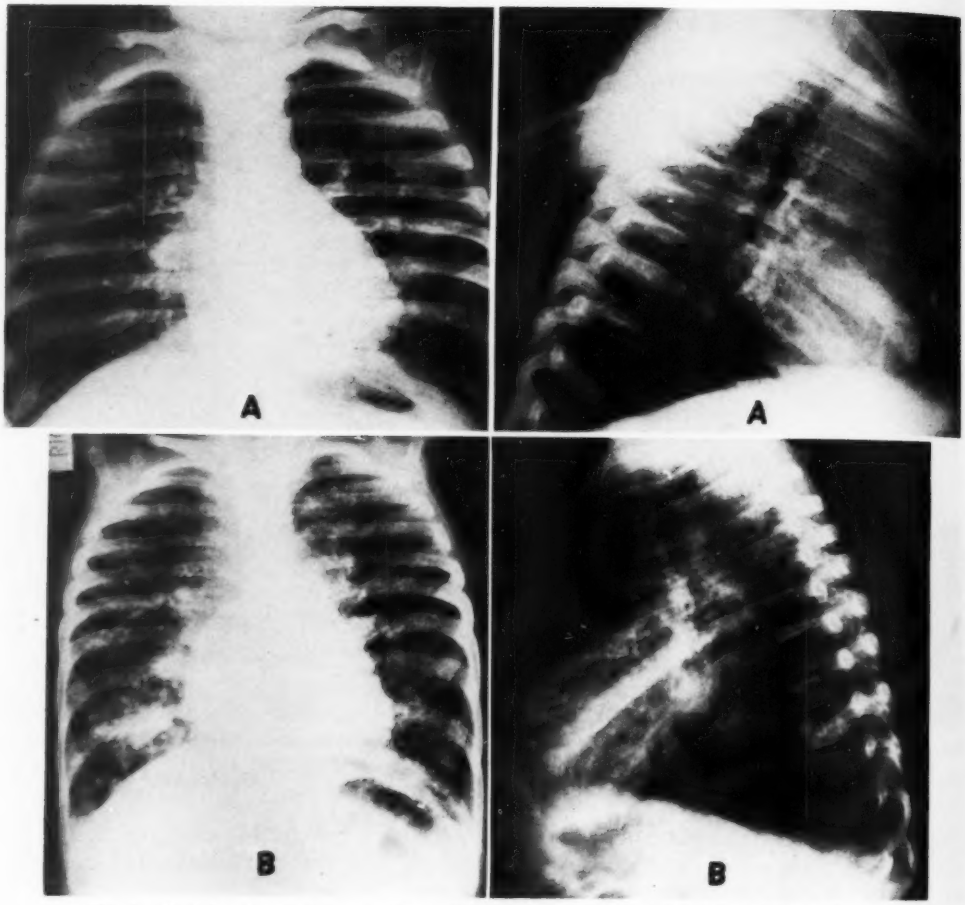
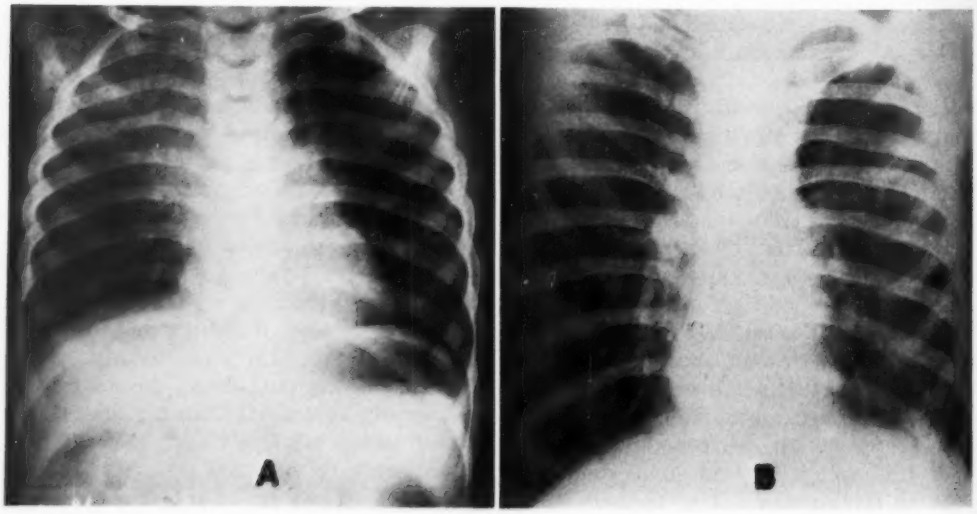


Fig. 4. Case I. A. At eleven months. Bilateral emphysema with minimal diffuse fibrosis.
B. At four years. Severe pulmonary fibrosis, emphysema, and focal pneumonitis in right lower lobe.



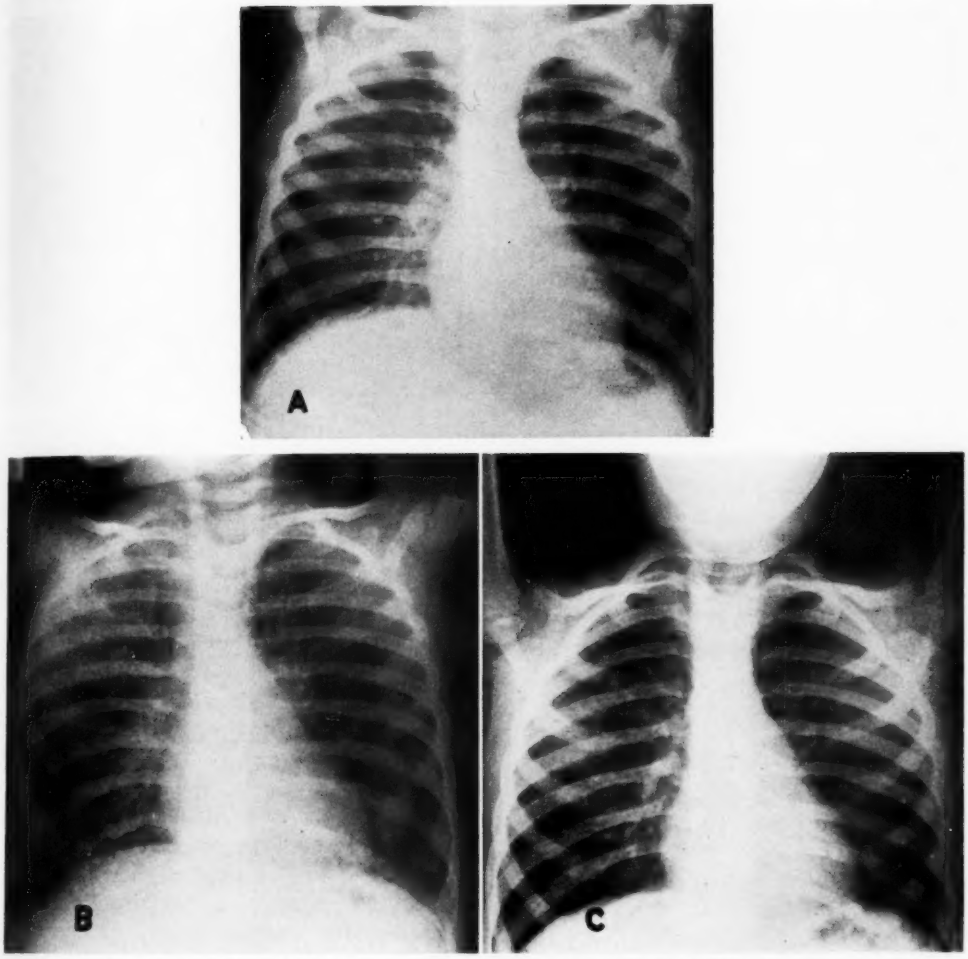
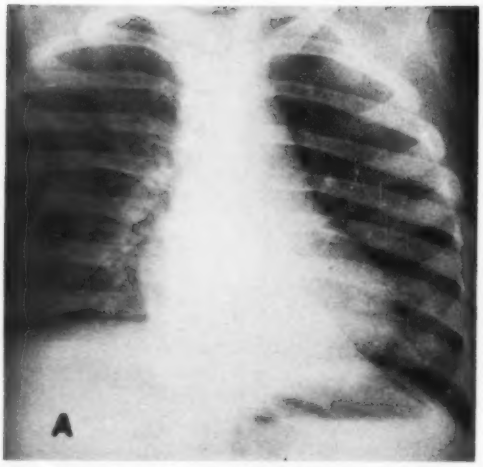


Fig. 6. Case III. A. At three years. Focal area of pneumonitis in right lower lobe.
B. Two months later. Diffuse bilateral miliary type infiltrate.
C. At four years. Complete clearing of lungs, without residuum.

The following are characteristics which the radiologist should be aware of as an aid in the diagnosis: (*a*) The disease is usually first manifested between the ages of six months and two years. (*b*) Three out of 4 cases of so-called nontuberculous bronchopneumonia in infancy are attributable to fibrocystic disease. (*c*) It is the leading cause of atelectasis in infants under one year. (*d*) Unexplained bronchiectasis and chronic asthma. In other words, one should have a high index of suspicion of fibrocystic disease in the presence of any persistent nontuberculous pulmonary lesion in infants and children.

The absolute diagnosis is made by the demonstration of a total or partial enzymatic deficiency in the duodenal secretions or an elevated sodium (over 80 mEq./liter) and chloride (over 60 mEq./liter) in the

← Fig. 5. Case II. A. At age of three years. Right upper lobe atelectasis and bronchiectasis.
B. At age of ten years. Minimal emphysema and minimal bilateral fibrosis.



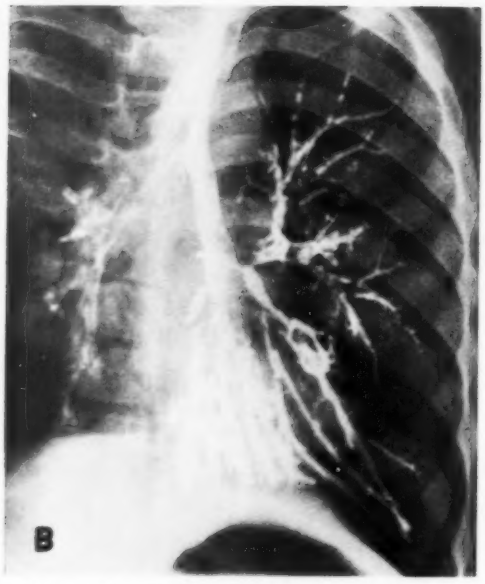


Fig. 7. Case IV, in child of four years. Atelectasis and bronchiectasis of left lower lobe. A. Chest roentgenogram. B. Bronchogram.

sweat (5). A simple modification of the sweat test, proposed by Schwachman (6), consists in making fingerprints on an agar plate of silver nitrate and potassium chromate (Fig. 1). When the sweat electrolytes are at a high level, prominent silver chloride prints are produced. The radiologist can facilitate the clinician's task of obtaining duodenal secretion by aiding him in passing a Levin tube into

Fig. 8. Case V, in infant of one month. Atelectasis and pneumonitis of right lung.

the duodenum under fluoroscopic control. This latter procedure is becoming less frequent because of the accuracy of the sweat electrolyte determinations and fingerprint test.

In the differential diagnosis the following conditions should be considered:

1. *Tuberculosis:* Differentiated by the Mantoux test and cultures.
2. *Chronic asthma:* History of allergy and negative sweat electrolyte test.
3. *Familial dysautonomia* (7): Roentgen features indistinguishable from fibrocystic disease; sweat test negative; history of excessive perspiration, drooling, and inability to produce tears; patients of Jewish extraction. These and other signs of autonomic dysfunction readily make the diagnosis.
4. *Aspiration pneumonitis* either from congenital paralysis of cranial nerves or tracheoesophageal fistula, etc.: Negative sweat test. Physical examination and investigation of the esophagus will make the differentiation.
5. *Agammaglobulinemia:* Sweat test negative; decreased gamma-globulin in the blood protein.

While in general the prognosis is poor, it is not hopeless. The offending organism, *Staphylococcus aureus*, responds to antibiotics. Surgeons are removing bronchiectatic and atelectatic portions of lung

where it is the major site of involvement, with reasonably good results. Once the patients reach the age of ten, their chances of improvement increase, probably because the larger bronchi can drain more efficiently. Intensive antibiotic therapy and surgery will undoubtedly prolong life, so that we will see these children reaching their teens and young adult years, with chronic pulmonary disease.

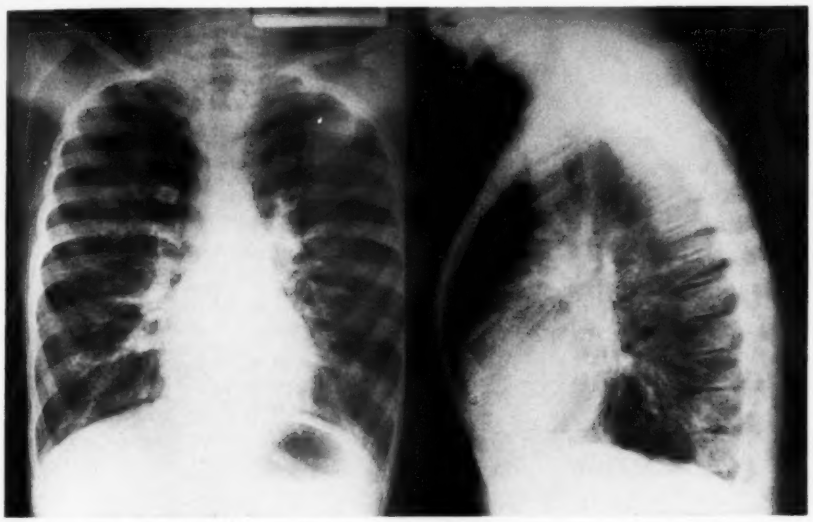


Fig. 9. Case VI, in eleven-year-old girl. Diffuse fibrosis and emphysema resembling chronic asthma.

As pointed out above, intestinal obstruction will develop in 10 per cent of these children in the neonatal period. Roentgenograms of the abdomen in the supine and upright position should be taken. Two signs have been described suggesting the preoperative diagnosis: (*a*) the "soap-bubble sign" of Neuhauser (8), which is the result of air mixed with meconium (Fig. 2), and (*b*) absence of fluid levels in the upright view (Fig. 3) originally described by Zimmer (9).

The pulmonary manifestations vary depending on the severity of the involvement. They are illustrated by the following cases:

CASE I: M. R. entered the hospital at the age of ten weeks, with a history of chronic cold, cough, and diarrhea. Two siblings had died of fibrocystic disease. The child was admitted to the hospital many times for recurrent upper respiratory infections and died at the age of four, of chronic cor pulmonale. No enzymes were present in her duodenal secretions. The vitamin-A curve was flat. Autopsy confirmed the diagnosis. Roentgenograms of the chest at eleven months (Fig. 4, A) revealed bilateral obstructive emphysema. At four years (Fig. 4, B) severe emphysema, fibrosis, and bronchopneumonia were demonstrated.

CASE II: W. L., one of twins, both of whom had fibrocystic disease, was seen at the age of eighteen months with a one-month history of foul stools, chronic upper respiratory infection, and loss of weight. Duodenal enzymes were markedly depressed. The vitamin-A curve was flat. At the age of three years a chest roentgenogram (Fig. 5, A) showed right upper lobe atelectasis that had been present for months, but little if any involvement of the rest of the lung. Lobectomy was performed and the lobe proved to be atelectatic and bronchiectatic. At the age of ten years, minimal pulmonary fibrosis was present (Fig. 5, B). The child is alive and doing fairly well.

CASE III: H. K. was first seen at the age of two years with a history of loose stools since birth. Laboratory studies revealed: sweat sodium, 121 mEq./liter; chloride 108 mEq./liter; absence of duodenal enzymes; flat vitamin-A curve.

At the age of three years, a focal area of pneumonitis was demonstrable in the right lower lobe (Fig. 6, A). This failed to clear, and two months later (Fig. 6, B) a diffuse almost miliary type bronchopneumonia was present. One year after this, fol-

lowing intensive antibiotic therapy, there was evidence of recovery (Fig. 6, C) and the child has been doing well since.

CASE IV: C. H. was first seen at nine months of age, with a history of cough since birth, and eventually died of diffuse bronchiectasis, pneumonitis, and atelectasis. A chest roentgenogram (Fig. 7, A) revealed focal atelectasis and a bronchogram (Fig. 7, B) showed bronchiectasis.

Case V: C. L., one month old, had a history of cough for three weeks. Death occurred shortly afterward and autopsy revealed severe pneumonitis and fibrocystic disease (Fig. 8).

CASE VI: H. K., eleven-year-old white female, had cough and dyspnea from the age of one and a half or two years. At admission she was orthopneic and cyanotic. Laboratory studies showed normal trypsin in the stool, sodium 85 mEq./liter, chloride 120 mEq./liter. The electrocardiogram was indicative of severe right heart strain (Fig. 9).

In Table I, from di Sant' Agnese (4), the changes that take place in the lungs are diagrammatically outlined.

SUMMARY

Fibrocystic disease of the pancreas is a serious exocrine gland disturbance found in infancy and childhood. Roentgen manifestations are limited primarily to the chest and abdomen.

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SUMMARIO IN INTERLINGUA

Morbo Fibrocystic Del Pancreas

Morbo fibrocystic del pancreas es un serie disordine de glandula endocrin occurrente in infantes e pueros. Le insufficientia del enzymas pancreatic e le alteration del mucoproteina in le secretion duodenal resulta in un meconio de spissitate e tenacitate anormal. Le secretiones in le pulmones es similemente spisse e tenace, resultante in dysdrainage pulmonar con subsequente obstruction intrabronchial e finalmente le disveloppamento de atelectasis, emphysema, bronchopneumonia, corde pulmonal, e morte.

Le radiologo es fortemente justificate a suspicer morbo fibrocystic del pancreas in le presentia de omne persistente lesion pulmonar de character non-tuberculotic in infantes e pueros. Ille debe notar (1) que le morbo usualmente se manifesta primo inter le etates de sex menses e duo annos, (2) que tres ex quatro casos del si-appellate bronchopneumonia non-tuberculotic in infantes es attribuibile a morbo fibrocystic, (3) que illo es le causa major de atelectasis in infantes de etates de minus que un anno, e (4) que bronchiectasis e asthma chronic non alteremente explicabile pote esser le effecto de iste causa.

Fluoroscopy in Pediatric Radiology and the Implications of Image Intensification[1]

JOHN A. KIRKPATRICK, Jr., M.D.

INCREASING KNOWLEDGE of the biologic effects of ionizing radiation necessitates constant reappraisal of radiologic technics. The aim of any diagnostic radiologic procedure is to establish an early and accurate diagnosis while exposing the patient to no more radiation than is necessary. Particularly in the pediatric age group, radiologic studies must be carefully selected so as to be informative and yet require a minimum of exposure to irradiation.

Fluoroscopy is a potentially hazardous tool because of the amount of exposure which is involved, but it is the one method by which physiologic phenomena are readily observed. When properly employed, it represents an invaluable adjunct to other radiographic studies. It should not, however, supplant the latter, since the physical factors are such as to allow fewer details to be appreciated at comparable exposures and since it affords no permanent record for future reference.

Although the limitations of fluoroscopy in infants and children parallel those in adults, the nature of certain disease processes in early life renders fluoroscopic examination of even greater value in this age group.

Acute inflammatory disease of the lungs in an infant may be first manifested by obstructive emphysema, which is difficult or impossible to recognize on radiographic study. Moreover, early in life emphysema may be the only manifestation of cystic fibrosis of the pancreas. Disturbances in aeration of the lungs, which are best recognized fluoroscopically, often accompany congenital lesions of the tracheobronchial tree, of the pulmonary parenchyma, and of the heart and great vessels, *e.g.*, congenital lobar emphysema, congenital adenomatoid malformations of the lungs, and vascular rings. Fluoroscopic observation in order to determine the size and nature of pulsation of the major vessels, the character of the intrapulmonary vasculature, and the configuration of the heart, is an integral part of the radiologic approach to congenital heart disease. Evaluation of esophageal activity in the infant who regurgitates may reveal a functional basis for such regurgitation. Under certain circumstances the diagnosis of pyloric stenosis and intussusception may be established by means of fluoroscopy and the diagnosis of aganglionic megacolon follows careful fluoroscopic study.

Recognition of the value of fluoroscopy in pediatric radiology implies not only an appreciation of the functional manifestations of disease but also of the possibilities for teaching and for research which are inherent in the method. Therefore, a device that produces a fluoroscopic image one-thousand times brighter than that of the conventional screen, with significantly lower exposure to the patient, must be considered a major radiologic advance.

An image intensifier of the electron optical type, manufactured by the North American Philips Company, Inc., has been in use for approximately one year at St. Christopher's Hospital for Children. This tube was readily adapted to a conventional fluoroscopic tower in a manner which permits spot-film radiography. The brighter fluoroscopic screen allows for safer clinical fluoroscopy and cinefluorography. As a result, for the past year all fluoroscopic examinations have utilized this device.

Fluoroscopy is done with the room

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lights on, at 0.5–1.0 ma and 60–70 kv, depending on the size of the patient. The output as measured at the top of the table is 1.03 to 1.85 r per minute. Dark adaptation is not necessary, and the levels of brightness are such that cone vision is utilized. A lighted room makes for a much more co-operative child, so that fluoroscopic time is decreased and the examination is rendered more accurate and definitive. The application of the method to special procedures such as bronchography, injections of sinus tracts, or to those procedures necessitating anesthesia allows for continuous clinical observation of the patient.

Although the area under observation is limited by the size of the screen (5 inches in diameter), in the infant and child this is no disadvantage and indeed is an additional safety factor. The shutter blades, however, must be evident within the screen of the image tube so that the beam of x-rays is no larger than the area which is being viewed. In infants this area is always smaller than the 5-inch circle. In contrast, conventional fluoroscopy of infants and children may readily result in whole-body irradiation. Thus, the method which has been described here offers a safer, easier, and more definitive fluoroscopic technic.

Cinefluorography must be mentioned in any discussion of image intensification because of the clinical, teaching, and investigative procedures made possible by the recording of the fluoroscopic image. A 16-mm. Bell and Howell motion-picture camera with an f.95 25-mm. lens is readily mounted on the image tube. Satisfactory motion pictures of physiologic phenomena have been made with exposures less than those usually employed in conventional fluoroscopy. Angiocardiography in infants lends itself to this technic and movies may be made at 64 frames per second. While detail is inferior to conventional radiographic technic, the dynamic aspects of the various chambers of the heart and of the great vessels are better appreciated. With a single relatively small exposure, a permanent record of many physiologic phenomena may be obtained. This can be studied in detail on repeated occasions and can be utilized for teaching with no additional exposure of the patient.

Because many movements which are observed fluoroscopically are rapid and transient, abnormalities of function characterized by alterations in these movements have not been recognized in conventional fluoroscopic examinations. By means of cinefluorography, however, it is possible to study these movements in detail, and previously unrecognized functional abnormalities can be identified. For example, we are now studying esophageal motility in patients who have had operative repair of esophageal stenosis or atresia, with or without tracheoesophageal fistula. It has become apparent that many of the postoperative feeding problems and pulmonary infections in these patients result as much from abnormal esophageal motility as from stenosis at the site of anastomosis. As technics and film are improved, investigation of a variety of cardiovascular, renal, and gastrointestinal phenomena will follow.

In conclusion, an appreciation of functional activity is essential to an understanding of many diseases peculiar to infants and children. Fluoroscopy with image intensification and cinefluorography are radiologic technics which allow the study of such phenomena at low exposures to radiation. Even these technics may be abused, however, and the utilization of ionizing radiation as a diagnostic tool in pediatrics must be carefully evaluated in every instance.

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SUMMARIO IN INTERLINGUA

Fluoroscopia In Radiologia Pediatric E Le Importantia Inherente De Intensification Del Imagine

Un appreciation del activitate functional es essential pro le comprehension de multe morbos que es particular a infantes e juveniles. Fluoroscopia con intensification del imagine e cinefluorographia es technicas radiologic que permitte le studio de tal phenomenos con basse grados de exposition radiatori. In plus, cinefluorographia es de valor pro objectivos de pedagogia e de recerca, proque illo permitte le obtention de un registration permanente de multe phenomenos physiologic al costo de un relativemente basse exposition a irradiation.

Urticaria Pigmentosa Associated with Widespread Sclerosis of the Spongiosa of Bone[1]

WALLACE N. JENSEN, M.D., and ELLIOTT C. LASSER, M.D.

SINCE THE REPORT of Sagher, Cohen, and Schorr (1) in 1952, recognition has been accorded the association of urticaria pigmentosa and roentgenographically demonstrable skeletal abnormalities. The changes described have varied but have usually consisted of diffuse or moderately diffuse osteosclerosis and, in some instances, other bony architectural changes (1–4).

Approximately 70 per cent of patients with urticaria pigmentosa have symptoms within the first year of life (5). The majority of this juvenile group exhibit dermatologic abnormalities, and evidence of systemic disease is rare. To the present time, 6 cases of urticaria pigmentosa and generalized bone lesions have been reported (1, 3–7). Hepatomegaly, splenomegaly, lymphadenopathy, anemia, leukopenia, leukocytosis, and thrombocytopenia have also been described in conjunction with the skin manifestations (1–14). It would thus appear that the entity previously designated as urticaria pigmentosa, characterized by intradermal collections of mast cells, is a localized or minor form of a pathologic process which may be widespread and involve many systems.

Fig. 1. Papular, umbilicated discrete and coalescent skin lesions over the lower extremities.
Fig. 2. Detailed view of skin lesions over lower extremity.

The presence of tissue mast cells in the liver, spleen, bone marrow, lungs, and in the peripheral blood in some pa-

[1] From the Departments of Medicine and Radiology, University of Pittsburgh Medical School, Pittsburgh, Penna. Accepted for publication in April 1958.

tients with urticaria pigmentosa has stimulated renewed interest in the origin and function of these cells. To date, the number of case reports of urticaria pigmentosa with systemic manifestations, or "malignant mastocytosis," is small, and knowledge of the underlying disease process is limited. For these reasons, the following case is reported and the literature is reviewed.

CASE REPORT

Mrs. D. T., a 68-year-old housewife, entered the hospital because of gaseous distention for three years and a rash of nine years duration on the lower extremities. She had enjoyed good health until nine years prior to admission, at which time she had a nonbacterial pneumonia which was treated with penicillin. Concurrently, there appeared small, red, papular lesions on the dorsal skin of the feet. The respiratory symptoms subsided, but the skin eruption spread upward to involve the anterior and posterior surfaces of the legs and, after a long period, the buttocks and the backs of the hands. The rash was asymptomatic; there was no weeping, exudation, vesiculation, urticaria, nor secondary infection.

Three years prior to the present admission, the patient had been admitted to another hospital for similar complaints and was found to have enlargement of the liver and spleen. On x-ray examination, osteosclerosis of the lower lumbar vertebrae was found, and a clinical diagnosis of agnogenic myeloid metaplasia was made. The peripheral blood was normal, and a bone marrow aspiration was not performed. During the year prior to the present admission, there had been a weight loss of 18 pounds, and ill-defined gastrointestinal complaints were present.

The family history was negative, and physical examination of two daughters showed no abnormalities.

Physical Examination: The patient's blood pressure was 180/100 mm. Hg, pulse 72/min., temperature 98.60° F, respirations 20/min. The head, eyes, ears, nose, and throat were normal. Lung fields were clear to percussion and auscultation. The heart was enlarged to the left, there was a grade I aortic systolic murmur, and the aortic second sound was accentuated. The liver was palpable 6 cm. below the right costal margin, and the spleen 5 cm. below the left costal margin. These viscera were smooth and nontender.

A scattered, reddish-purple, papular eruption was present over the feet, legs, and buttocks. Over the lower legs and feet the lesions were coalescent; isolated lesions frequently showed umbilication. There was no evidence of wheal formation, exudation, vesiculation, hemorrhage, or secondary infection (Figs. 1 and 2).

Fig. 3. Film of lumbar vertebrae taken three years before admission. Diffuse sclerosis is apparent.

Laboratory Data: The serologic test for syphilis was negative. Urine analysis was normal except for the demonstration of numerous leukocytes. Routine hematologic determinations were normal except for a persistent total leukocyte count near 4,000 per cu. mm. Coagulation protein studies showed normal concentrations of prothrombin, antihemophilic globulin, plasma thromboplastin component, and proconvertin. Circulating anticoagulants were not present. Bleeding time, coagulation time, and clot retraction were normal; but the tourniquet test was repeatedly positive.

Blood chemistry, including blood sugar, blood urea nitrogen, uric acid, calcium, phosphorus, alkaline phosphatase, bilirubin, sodium, potassium, and chlorides, was normal. There was 7.5 per cent retention, after forty-five minutes, of a 5 mg./kg. dose of bromphenolsulfonthalein; the total serum protein was 7.2 gm. per cent, with albumin 3.4 gm. per cent, and globulin 3.8 gm. per cent. Paper electrophoresis of the serum protein showed a marked increase in gamma globulin. Attempts to demonstrate L.E. cells, cold precipitable proteins, and macroglobulins were unsuccessful.

The chest film showed the heart to be enlarged in its transverse diameter, with aortic ectasia. Films

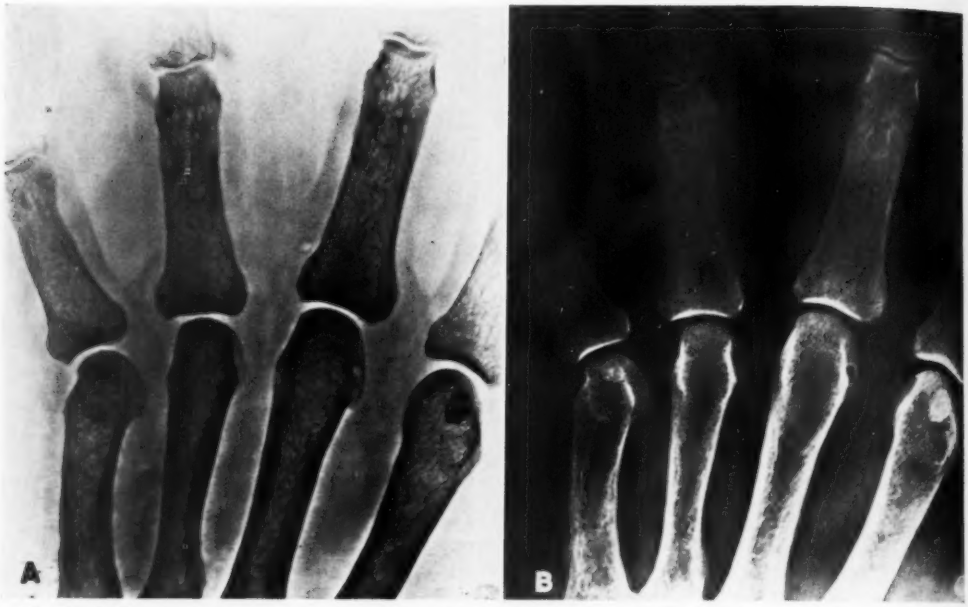


Fig. 4. Diffuse trabecular development is seen in positive (A) and negative (B) reproductions. Compare with Fig. 5.

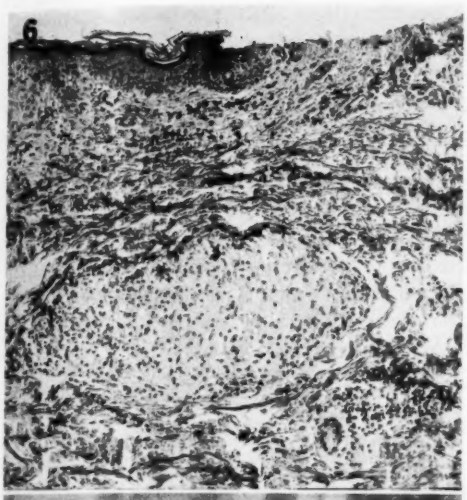
Fig. 5. Roentgenogram of hand of female subject in same age group as patient, for comparison with Fig. 4.

of the abdomen showed hepatomegaly and splenomegaly. Other roentgenologic examinations will be discussed separately. The electrocardiogram showed changes compatible with left ventricular preponderance.

Roentgenographic Observations: All of the bones examined showed an unusual thickening of the trabecular structure, resulting in an impression of generalized osteosclerosis (Fig. 3). Special views of the skull revealed obliteration of the diploic structure of the cranial vault, with indistinguishable inner and outer tables, and prominent, compact, dense diploic architecture at the base. In the hands a tightly woven trabecular structure was demonstrable throughout the length of the metacarpal and phalangeal bones (Fig. 4). The uniform, heavy trabecular pattern found throughout the length of the metacarpals and phalanges in this patient is in striking contrast to the normal diaphyseal atrabecular area noted at this age (Fig. 5).

Hematologic Observations: Repeated examinations of the peripheral blood failed to reveal abnormalities except for a moderately severe normocytic, normochromic anemia. Bone marrow obtained by needle aspiration and by direct biopsy was without evident tissue mast cells. Smears of material obtained by splenic aspiration were normal. Of interest was the leukocyte alkaline phosphatase activity, which was found to be normal as determined by the cytochemical method of Kaplow (15).

Hepatic Observations: Histologic examination of



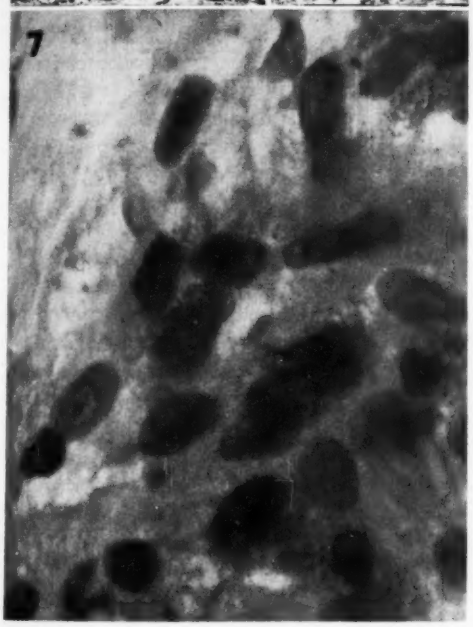


Fig. 6. Skin biopsy, showing focal granuloma. Hematoxylin-eosin. ×110.

Fig. 7. Skin biopsy showing aggregates of mast cells and cytoplasmic metachromatic granules. Toluidin blue. ×900.

hepatic tissue obtained by biopsy showed normal liver. Hepatic wedge pressure, obtained by the technic described by Taylor and Myers (16), was 6 mm. Hg, and the splenic pulp pressure, determined by percutaneous splenic puncture, was 10 mm. Hg.

Skin, Muscle, and Bone Biopsies: Samples of skin and muscle taken from two separate but involved

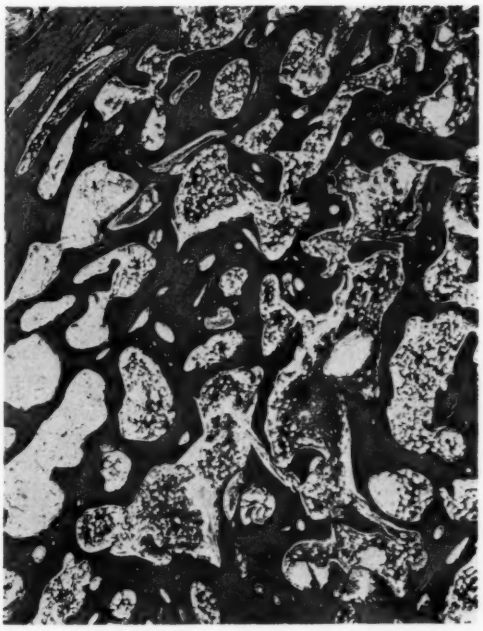


Fig. 8. Bone and bone marrow biopsy showing remarkable increase in bone trabeculae. Hematoxylin-eosin. ×70.

sites showed the same histologic features. There were slight hyperkeratosis and focal prominence of the stratum granulosum. In the upper dermis there were focal and linear collections of large histiocytes, lymphocytes, and plasma cells. A small number of the histiocytes contained yellow-brownish granules, the majority of which were iron negative. Toluidine blue stain showed numerous tissue mast cells in the dermis (Figs. 6 and 7). The findings were considered to be those of urticaria pigmentosa. The muscle biopsy was normal.

A bone biopsy obtained from the crest of the ilium was normal in gross appearance.

Microscopic examination of the bone and bone marrow biopsy showed the cancellous trabeculae to be approximately twice the normal thickness, with decreased marrow spaces containing normal marrow (Fig. 8). Attempts to stain the metachromatic granules were unsuccessful, possibly because of the prolonged decalcification process used in preparation of the specimen. Mast cells, identifiable by metachromatic granule staining characteristics, were not observed and granulomata were absent.

DISCUSSION

Whether or not a fundamental relationship exists among the various clinical disorders which are characterized by either

local or systemic accumulations of mast cells is unknown. Sagher (2) has recently suggested a descriptive classification of the various tissue mast-cell disorders based on clinical findings. In addition to urticaria pigmentosa, malignant mastocytosis, and tissue mast-cell leukemia, there are other diseases such as myelosclerosis, chronic granulocytic leukemia, panmyelopathy, and aplastic anemia which are accompanied by either generalized or local tissue mast-cell proliferation (17–19).

Osteosclerosis of this type is uncommon in diseases other than myelosclerosis, fluorine poisoning, and urticaria pigmentosa. A review of the skeletal changes in urticaria pigmentosa by Sagher and Schorr (2) led to the conclusion that the bony lesions are of two types: (*1*) a generalized type with cystic osteoporosis of the ribs, thickened bony trabeculae, stippling of the bony structures of the cranium, thickened skull tables, and generalized sclerosis of the pelvic bones and vertebrae; (*2*) a localized type with calcific deposits and decalcified areas of various sizes in the humerus, radius, femur, skull, and scapula.

In this case, the skeletal changes are consistent with those of the first type. Analysis of some of the reproductions and reports of the localized type of bone change as reviewed by Sagher and Schorr would seem to cast doubt on their significance. Included in the localized group, for example, are 2 cases reported by Clyman and Rein (20), 1 of which showed changes resembling bone infarcts, and the other the classical changes of hereditary deforming chondrodysplasia. Also, there are cases reported as abnormal because of "osteoporosis of the skull," "tiny areas of questionable radiolucency in the medial malleolus of the right ankle," "a small ill-defined defect in the right frontal bone about 5 mm. in diameter," and a case showing "the epiphyseal center of the left capitulum humeri and both olecranons and left trochlea extremely irregularly divided into several small fragments" (21, 2, 12, 11). Since in none of these cases does there appear to have been biopsy confirmation of the areas under suspicion, and since most of these changes fail to exhibit a common pattern, it would seem that, for the present at least, only those patients with the generalized form of osseous involvement may be regarded with any degree of confidence as having systemic urticaria pigmentosa. Our case, then, would appear to be the seventh of urticaria pigmentosa with generalized bony involvement to be reported in the English literature.

A more detailed analysis of the reported changes shows them to be confined almost entirely to cancellous bone, with an increase in thickness and in numbers of spongy trabeculae which obliterate the normal architectural pattern and contribute to the overall effect of osteosclerosis. In the case reported here, the changes are particularly striking in the phalanges and metacarpals, where the normal diaphyseal "clear zone" which ordinarily represents the marrow cavity covered by compact bone was replaced by a tightly woven pattern of cancellous bony trabeculae.

Extraskeletal systemic manifestations of tissue mast-cell disease include hepatomegaly, splenomegaly, lymphadenopathy, and the demonstration of increased mast cells in bone marrow, splenic aspirates, or peripheral blood. Hemorrhagic manifestations, without the presence of demonstrable circulating anticoagulants but with thrombocytopenia, have been found in a number of cases (3, 10, 22). In a few instances (3, 23), the patients have died with a disease thought to resemble leukemia and have exhibited infiltrates or tissue mast cells throughout all tissues of the body. In certain of these patients, urticarial cutaneous lesions were present; in other, nonurticarial dermatitis was found; in still other patients, cutaneous manifestations were not present.

The studies of the splanchnic circulation and of the liver function are of interest in that hepatic lesions suggestive of cirrhosis or actual cirrhosis have been found in patients with urticaria pigmentosa

(5, 8, 24), and since dogs with mast-cell tumors have shown some evidence of portal fibrosis (25). Although there had been hepatomegaly and splenomegaly of at least three years duration, liver function tests, the liver biopsy, and the portal venous pressure as reflected by hepatic wedge pressure and by splenic pulp pressure were normal.

The failure to find tissue mast cells in the splenic aspirate and the bone marrow aspirate is similar to the experience cited by others, even when such cells have been shown to be present in large numbers in the spleen and bone marrow after surgical biopsy or upon postmortem examination of these tissues (8). This finding deserves emphasis, since it seems quite likely that urticaria pigmentosa with systemic involvement may be confused with myeloproliferative diseases.

The previously posed "riddle of the tissue mast cell" (26) is seemingly not closer to a solution as a result of the clinical observations of mast-cell diseases made during the past few years. It would appear that in man, increased numbers of tissue mast cells may exist in the skin, bone marrow, spleen, liver, and loose connective tissue, either with or without the apparent elaboration of heparin-like substances and with or without the local systemic effects of histamine release. It is of considerable interest, however, that in a number of diseases characterized by new medullary bone formation there exists an increased number of mast cells. Although mast cell proliferation may be seen in certain diseases without medullary bone formation or osteosclerosis, attention might profitably be focused on the possible relationship between tissue mast cells and the formation of new bone.

SUMMARY

A case of urticaria pigmentosa with cutaneous and osseous lesions and involvement of abdominal viscera (Sagher's Type 1) is presented; the osseous roentgenologic findings and the clinical aspects are discussed, and the pertinent literature is reviewed.

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SUMMARIO IN INTERLINGUA

Urticaria Pigmentose, Associate Con Extense Sclerosis Del Spongiosa De Osso

Il pare que le entitate previemente designate como urticaria pigmentose, characterisate per collectiones intradermal de mastzellen, es un forma localisate o minor de un processo pathologic que pote esser extense e que pote interessar multe systemas. Le autores reporta un caso de urticaria pigmentose con lesiones cutanee e ossee e affection del visceres abdominal. Le associate alterationes ossee es quasi completemente limitate al ossos cancellose, con un augmento in spissitate e in le numero de trabeculas spongiose que oblittera le normal structura architectural e contribue al effecto general de osteosclerosis. In le caso reportate, le alterationes esseva particularmente frappante in le phalanges e le metacarpales.

Tuberous Sclerosis[1]

Report of a Case with Ependymoma

W. C. MacCARTY, JR., M.D.,[2] and D. G. RUSSELL, M.D.[3]

TUBEROUS SCLEROSIS is a relatively rare familial disease. The basic disorder is a defect in development of ectodermal structures, usually with a widespread distribution involving many systems. The classical clinical triad consists of mental deficiency, epilepsy, and sebaceous adenomas of the face. Because the ectodermal structures are basically involved, it is to be expected that the central nervous system will show frequent and varied lesions.

The term tuberous sclerosis is derived from Bourneville's original description of the "potato-like" nodules scattered indiscriminately throughout the cortex of the brain (2). These nodules are of a pale color, are slightly more firm than cortical substance, and range in size up to 3 cm. in diameter. Microscopic examination of the cortical masses shows giant nerve cells, proliferation of the glial elements, and large astrocytes. Other distinctly separate lesions are subependymal tumor masses, usually in the lateral ventricles. These may protrude slightly or may be of sufficient size to fill the ventricle completely. The subependymal tumors are made up predominantly of glial cells and giant astrocytes. Malignant degeneration in the form of glioma has been recorded arising in these brain nodules (7, 13, 16). Congenital tumors of the retina, called "phacomas," are also seen.

In addition to the typical sebaceous adenomas of the face, other skin lesions have been described (3): (*a*) plaques of thickened skin over the lumbosacral region, termed "shagreen skin" or *peau de chagrin;* (*b*) subungual fibromas, which are small red proliferations at the border of the nails; (*c*) café-au-lait spots and vitiligo; (*d*) subcutaneous nodules resembing fibromas.

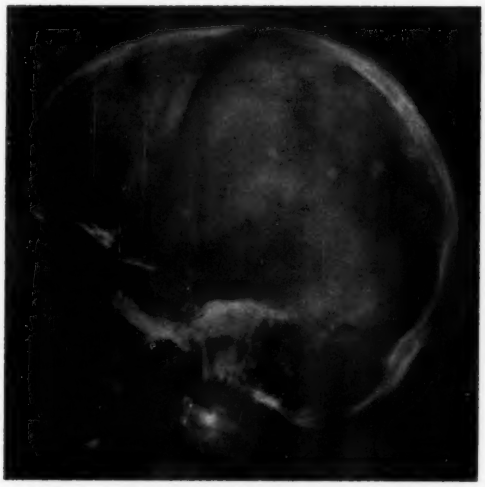

Fig. 1. Case I. Skull film taken on admission. The relationship of the intracranial calcification to the ventricles is demonstrated in Figs. 4 and 5.

Visceral lesions have been reported in almost every organ. These consist of mixed embryonal elements and are often described in terms of the predominant tissue, *i.e.*, hemangioma, lipoma, myoma or fibroma. These tumors are common in the kidney and may become malignant, presenting as hypernephroma or liposarcoma (6, 9).

An increased incidence of congenital anomalies is observed in families with tuberous sclerosis. These include harelip, polydactylism, spina bifida, and congenital heart disease.

Roentgenograms of patients with tuberous sclerosis depict some fairly characteristic findings. Ross and Dickerson (15) were able to demonstrate intracranial calcification in 60 per cent of their cases. These irregular discrete areas of calcification are found occasionally within the cortical

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Figs. 2 and 3. Case I. Cystic areas in the distal phalanges are well demonstrated. There is no periosteal proliferation along the shafts.

Fig. 4. Case I. Note the mass in the anterior horn of the right lateral ventricle and the irregularity along the roof of the ventricle. The latter is a common finding, described as "candle guttering."

Fig. 5. Case I. Ventriculogram. The filling defect in the right lateral ventricle is again visualized. The extent of the hydrocephalus is well shown.

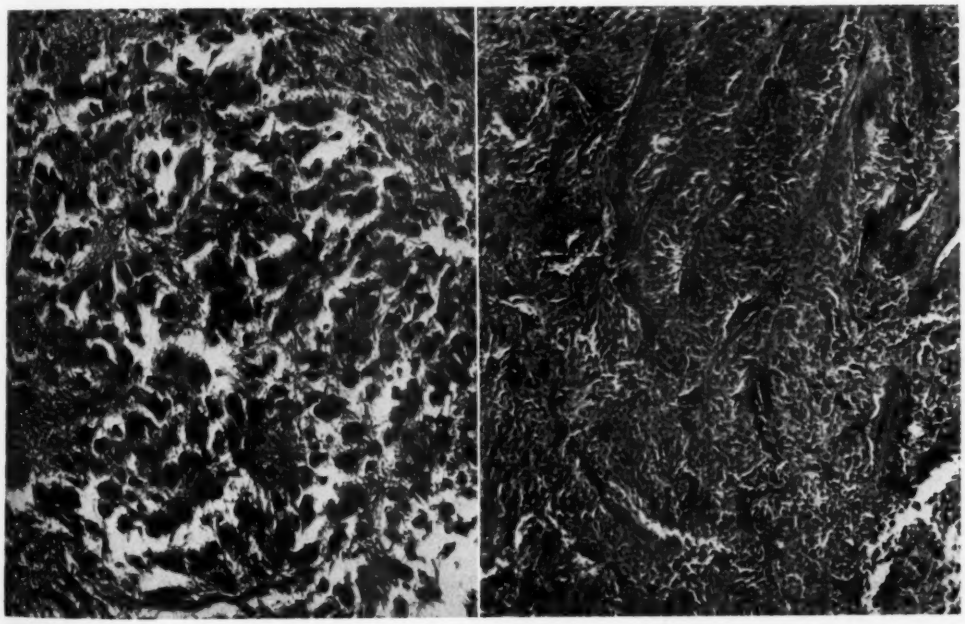
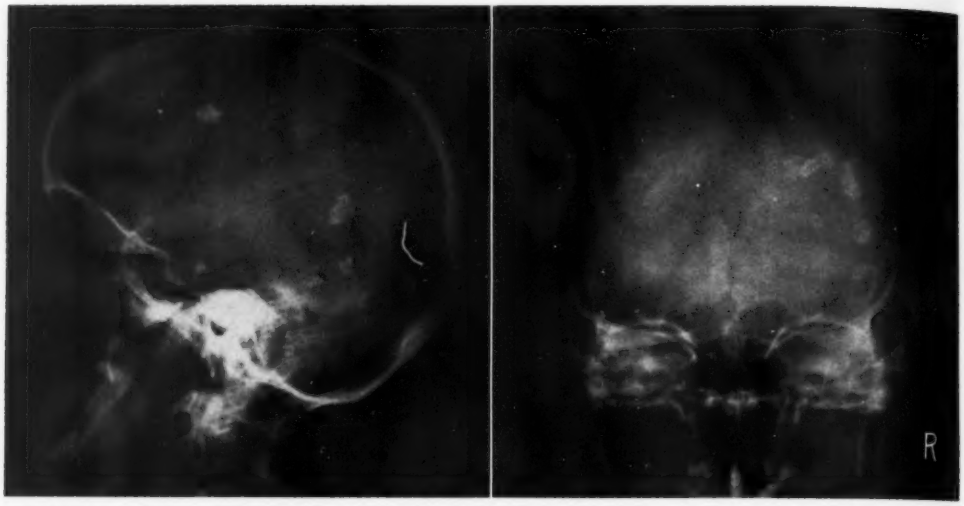


Fig. 6 (left). Microscopic section from right lateral ventricle. Note the characteristic large protoplasmic astrocytes and the abundance of glial fibers.

Fig. 7 (right). Microscopic section of ependymoma of right lateral ventricle. Note the typical arrangement of ependymal cells radiating out from blood vessels.



Figs. 8 and 9. Case II. The configuration and size of the intracranial calcifications are characteristic of tuberous sclerosis. The unilateral distribution is not a usual finding.

nodules and more frequently within the subependymal masses. Holt and Dickerson (8) noted rounded patches of sclerotic bone involving the inner table of the calvarium in 40 per cent of their patients. Frequently these overlie the cortical tuberous nodules. Ventriculograms often show the subependymal tumors appearing as small protrusions or large filling defects within the lateral ventricles. Radiographs of the hands and feet reveal characteristic cysts in the phalanges and periosteal new bone formation in the metatarsals. Ashby and Ramage (1) have recently described patchy sclerotic areas in the vertebrae and innominate bones in a patient with tuberous sclerosis. These must be differentiated from osteoblastic metastases or Paget's disese. Pulmonary involvement, of rare occurrence (5), causes overgrowth of connective tissue and cyst formation, producing a fine generalized reticular pattern and honeycombing on the roentgenogram.

The following is the case history of a patient with tuberous sclerosis in whom an ependymoma developed.

Case I: A 24-year-old white female, one week postpartum, was admitted to the Mary Hitchcock Memorial Hospital with severe right-sided headaches of one week duration and diplopia and blurred vision for three days. The patient's mentality was retarded. There was no history of epilepsy. Examination revealed a blood pressure of 170/80 with normal pulse and respirations. There were typical sebaceous adenomas over both upper cheeks and a slightly raised, pale red plaque over the sacrum, typical of "shagreen skin." On the left mid-finger was a paraungual fibroma. Funduscopic examination showed bilateral papilledema and some hemorrhage and exudate on the left. There were no phacomas.

Skull roentgenograms revealed scattered areas of intracranial calcification (Fig. 1). There were no sclerotic patches on the inner table. Radiographs of the hands demonstrated cystic areas in the distal phalanges (Figs. 2 and 3). The feet were normal.

Ventriculography revealed tumorous protrusions into the lateral ventricles and a filling defect in the anterior horn of the right lateral ventricle (Figs. 4 and 5). The lateral ventricles were dilated. The cerebrospinal fluid pressure was 600 mm. of water and the protein content was 726 mg. per cent. A right ventriculomastoidostomy relieved the symptoms, and the intraventricular pressure returned to normal.

The patient was discharged on the twenty-fifth postoperative day and returned two weeks later with headaches, vomiting, and ataxia. The ventriculomastoidostomy tube was found to be plugged, and the symptoms were relieved following irrigation. Repeated ventricular taps were required because of occlusion of the tube, and sixteen days following the second admission a craniotomy was performed. A red friable tumor was removed piecemeal from the right lateral ventricle. This mass occupied almost

Fig. 10. Case III. Film taken on admission in 1954, at the age of fourteen months. No abnormality is noted.

Fig. 11. Case III. Film taken in 1957. Note the faint calcification indicated by the arrow.

all of the ventricle and was attached at the foramen of Monro. Histologic examination showed two distinct elements: protoplasmic astrocytes in a bed of glial fibers (Fig. 6), which are characteristic of the nonmalignant subependymal masses seen in tuberous sclerosis, and ependymal cells arranged in a "rosette" pattern around blood vessels, which supports the diagnosis of ependymoma (Fig 7). The patient died on the fifth postoperative day.

At autopsy the diagnosis of tuberous sclerosis was confirmed. Additional anatomic diagnoses included interauricular septal defect and leiomyoma of the heart, liver, vaginal wall, and lungs. The lung lesions were not visible on the chest film.

Following the diagnosis of this case, members of the family were studied and two additional cases of tuberous sclerosis were discovered.

Case II: The patient's mother, age 57, is mentally retarded, with a history of numerous convulsions as a child. This woman's ten pregnancies included four miscarriages and two neonatal deaths. Her mother was reported to have had numerous fits. Two brothers died in infancy, one of "fits" at the age of eight and another of questionable hydrocephalus at the age of twelve. Examination revealed adenoma sebaceum of the face and paraungual fibromas of several toes. Skull roentgenograms showed scattered intracranial calcification (Figs. 8 and 9). Roentgenograms of the hands and feet were normal. A clinical diagnosis of tuberous sclerosis was established.

Case III: One of the children of our patient, a male aged 4, had previously been admitted at the age of fourteen months with a history of grand mal seizures occurring frequently for seven months. An accessory left thumb had been removed in early infancy. Skull films at that time were normal (Fig. 10). Roentgenograms of the skull now revealed a single small area of intracranial calcification (Fig. 11). As yet other stigmata characteristic of tuberous sclerosis had not appeared.

A second offspring, a female aged three, had a history of occasional petit mal seizures. Her general examination and roentgenograms were normal. It is certainly conceivable that recognizable tuberous sclerosis will eventually develop to explain her epilepsy.

Nine other members of the family were examined and no evidence of tuberous sclerosis was found.

SUMMARY

Tuberous sclerosis, a relatively rare familial disease, is reviewed briefly. The roentgenographic contributions to the diagnosis are summarized. Occasionally neoplasms in the form of gliomas develop in patients with tuberous sclerosis. Such a case is reported. Subependymal glial proliferations may become large enough to produce obstruction and chronic hydrocephalus. In the presence of acute signs and symptoms of hydrocephalus, a malignant change should be suspected. If other members of the family are examined, additional cases of this disease may be uncovered.

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SUMMARIO IN INTERLINGUA

Sclerosis Tuberose: Reporto De Un Caso Con Ependymoma

Sclerosis tuberose es un relativemente infrequente morbo familial que se manifesta usualmente in le triade clinic de defectivitate mental, epilepsia, e adenomas sebacee del facie. Le systema nervose central exhibi frequente e varie lesiones, notabilemente nodulos "patatiforme" in le cortice cerebral e tumores subependymal in le ventriculos lateral. Iste ultimes pote devenir satis grande pro resultar in obstruc-

tion e le symptomas de hydrocephalo. A vices neoplasma se disveloppa in le forma de gliomas.

Calcification intracranial es un frequente constatation roentgenologic. Ventriculogrammas monstra frequentemente le tumores subependymal con le apparentia de micre protusiones o de grande defectos de replenation intra le ventriculos lateral. In le manos e pedes, cystes es frequentemente demonstrabile in le phalanges, con neoformation periosteal in le metatarsales.

Es reportate un caso in que un ependymoma se disveloppava. Le examine de altere membros del mesme familia resultava in le discoperta de duo casos additional de sclerosis tuberose—un in le matre del patiente, le altere in un puero.

Fixed Defects in the Gallbladder Wall[1]

EDWARD A. TEN EYCK, M.D.

SINGLE OR MULTIPLE fixed filling defects in the gallbladder are not uncommonly disclosed by oral cholecystograms. In 1931 Kirklin (14) reported the first 4 cases of papilloma of the gallbladder diagnosed by cholecystography and confirmed by surgery. In his paper, he stated that Carman had predicted in 1925 that such a diagnosis should be possible. However, he had not lived to see his prediction come true.

Since Kirklin's original report, American and British investigators (2, 3, 6–8, 12, 15, 17–23, 26, 29) have described approximately 50 cases of radiographically diagnosed polypoid gallbladder lesions which have been confirmed by surgery. There have been numerous other reports of benign gallbladder polyps or tumors which were not diagnosed by preoperative cholecystograms (1, 9, 10, 24, 25, 27, 28, 30).

Because of the confusion in the terminology of benign gallbladder neoplasms, it has been impossible to ascertain the incidence of various types of polypoid lesions. This situation was first emphasized by Kerr and Lendrum (13) in 1936 with their critical review of reported cases up to that time and has been somewhat clarified in recent years by several authors. The confusion centers mainly around the term papilloma, which has been indiscriminately used to include a variety of lesions. Actually it should be reserved for true neoplastic lesions of the gallbladder wall. It has been erroneously applied to cholesterol polyps associated with cholesterolosis and inflammatory hyperplasias associated with chronic cholecystitis.

PRESENT STUDY

From 1952 to 1957, a total of 2,544 cholecystectomies were performed at The New York Hospital. While cholecystograms were not obtained for all cases examined pathologically, they were available for all patients found to have polypoid lesions. Of the total number of cases with cholecystograms, 22 showed one or more fixed filling defects.

Fig. 1. Cholecystogram showing multiple filling defects from multiple cholesterol polyps.

The largest group showing such defects comprised 18 cases of cholesterol polyps (Figs. 1 and 2). In 16 of these patients there was one filling defect, and in 2, multiple defects were demonstrated (Fig. 1). Cholesterolosis (4, 11) may manifest itself either by diffuse infiltration of the epithelium and stroma with lipid-filled macrophages or by localized aggregations of macrophages. The latter are evident on cholecystograms when they are of sufficient size. In this series, polyps less than 3 mm. in diameter were not demonstrable. Among the 2,544 gallbladders examined in the Surgical Pathology Department, 121 lesions were classified as cholesterolosis. Thus, 15 per cent (18 of 121) of cases of cholesterolosis were demonstrable cholecystographically. Although most of the remaining cases were

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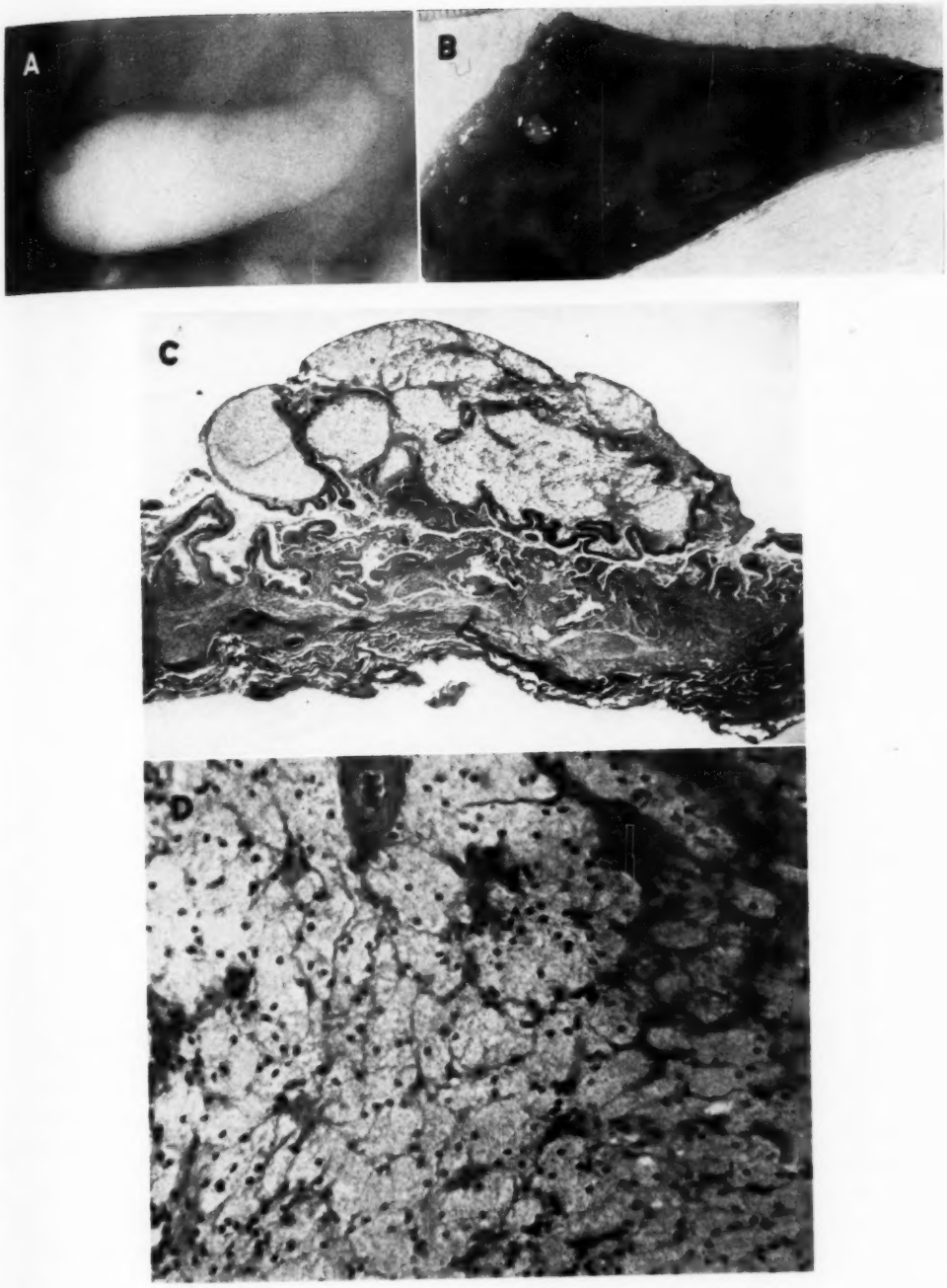

Fig. 2. Cholesterol polyp. A. Cholecystogram showing a fixed defect in the fundus of the gallbladder. B. Photograph of the gross specimen, showing a 5-mm. cholesterol polyp. There are also several smaller polyps. C. Low-power photomicrograph of the entire polyp. D. High-power photomicrograph showing the lipid-filled macrophages.

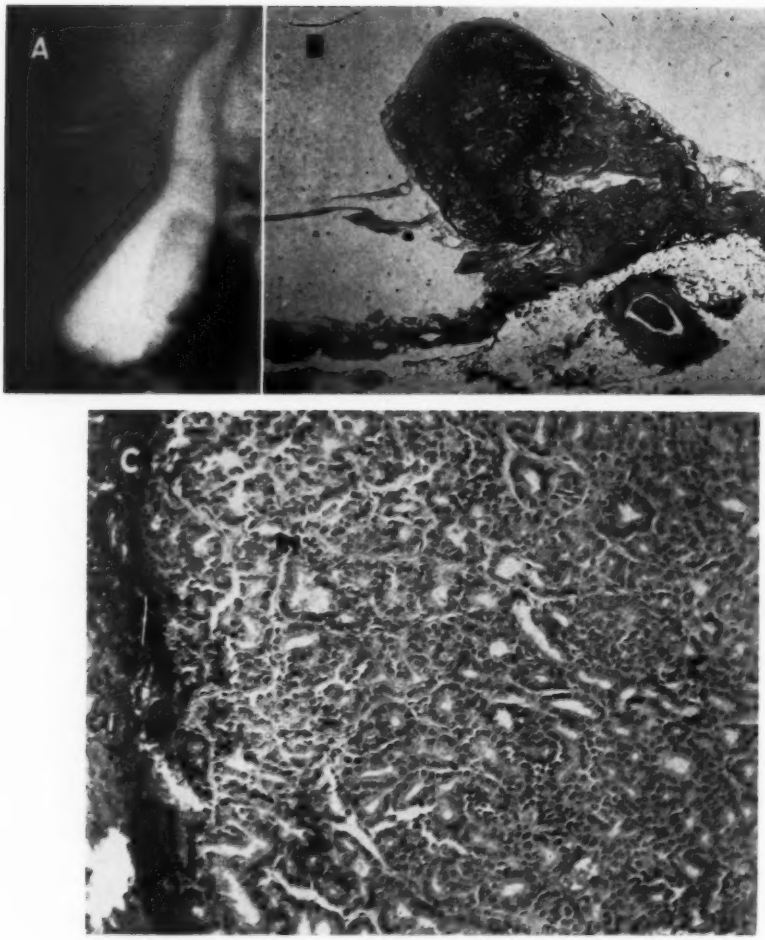

Fig. 3. Papilloma. A. Cholecystogram showing a fixed defect in neck of the gallbladder. B. Low-power photomicrograph of the entire polyp. C. High-power photomicrograph. There is no evidence of malignancy.

of the diffuse type of cholesterolosis, there were some polypoid types. The latter were not demonstrated, either because of inadequate size, non-function, or associated calculi. It has been speculated that some of these polyps break off and form the nidus for a calculus.

Only one fixed filling defect in this series represented a true papilloma (Fig. 3). The chances of making this diagnosis radiographically are poor. Five other cases were identified pathologically as true papillomas. These, however, were all associated with calculi and were not recognized on the cholecystogram. It has been stated that these lesions, like papillomas of the colon or urinary bladder, are potentially malignant. Tabah and McNeer (29) reported 4 cases of papilloma of the gallbladder, 3 of which showed carcinoma *in situ*.

In the presence of a defect, inflammatory polyps (Fig. 4) from epithelial proliferation secondary to chronic cholecystitis must be considered. Only 1 such case was demonstrated on the cholecystogram. Five others found on pathologic examination had not been identified preoperatively. The gallbladder was non-

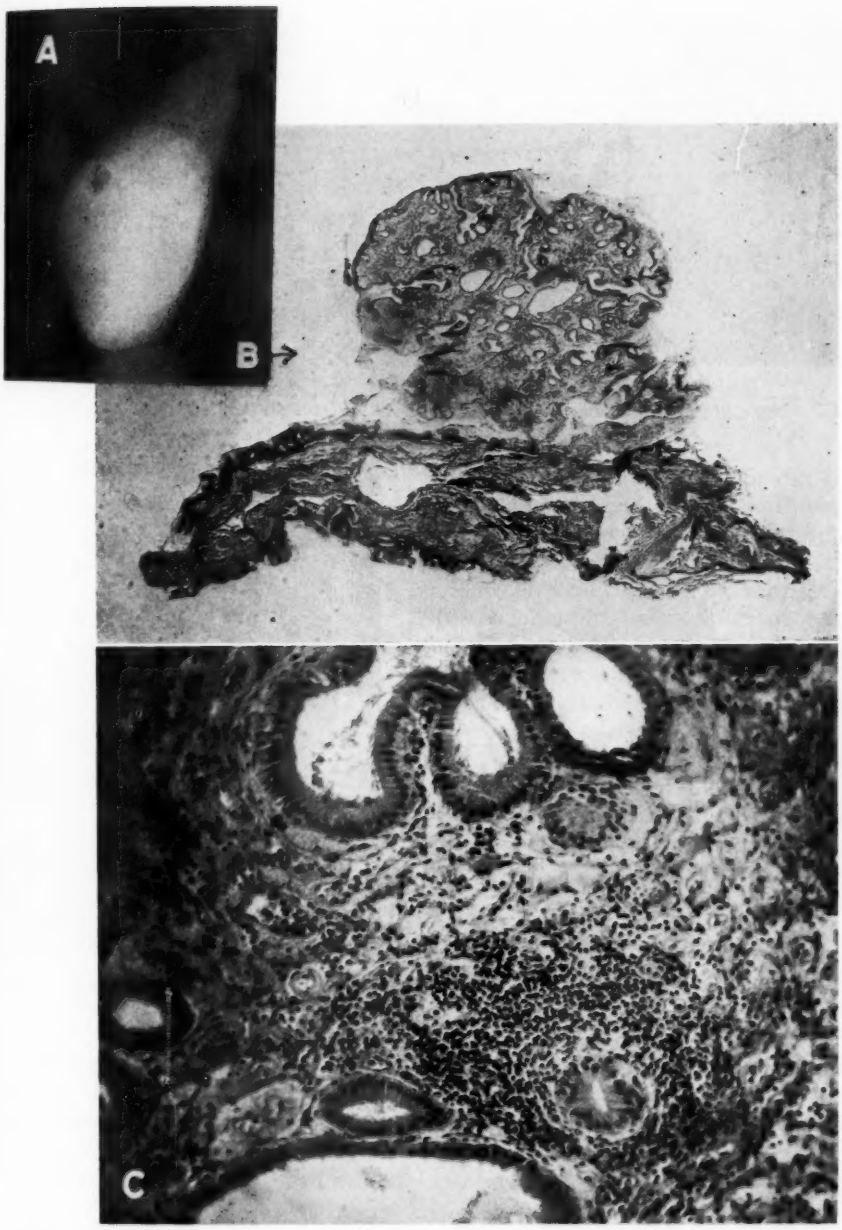

Fig. 4. Inflammatory polyp. A. Cholecystogram showing a fixed defect in the body of the gallbladder. B. Low-power photomicrograph of the entire polyp. C. High-power photomicrograph showing epithelial and stromal proliferation with inflammatory infiltrate.

functioning in 2 of these cases, and the other 3 showed multiple calculi.

An unusual and interesting defect was caused by a large, thick-walled arteriosclerotic vessel which formed a 2 × 3-mm. localized polypoid elevation of the mucosa (Fig. 5). Feldman and Goodman (5) reported the only other vascular lesion

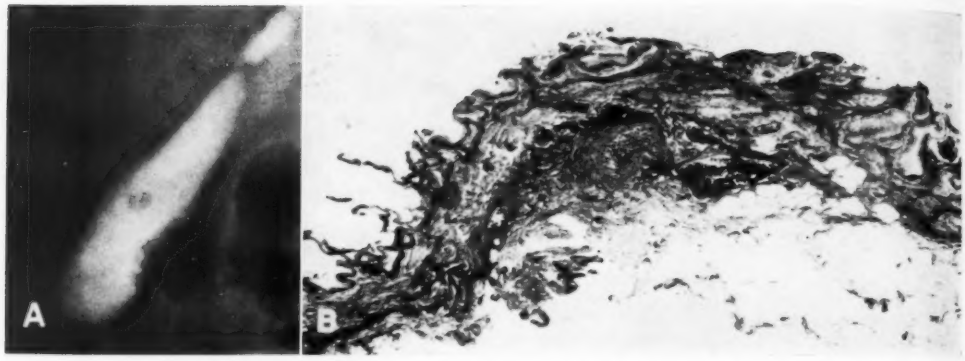

Fig. 5. Arteriosclerosis. A. Cholecystogram showing a fixed defect in the body of the gallbladder. B. Low-power photomicrograph showing the large thick-walled vessel beneath the epithelium.

of the gallbladder wall in the literature—varices associated with a mucosal cyst. The lesions were demonstrated on the preoperative cholecystogram.

A rare cause of a fixed filling defect is a gallstone fixed to the gallbladder wall (Fig. 6). One of our cases demonstrated this entity. Films of the operative specimen taken with a contrast medium, in the erect position, showed no movement of the defect. While the specimen was being opened, however, the firm calculus was dislodged. It was coated with a sticky, mucoid material, by which it apparently was attached to the wall of the viscus.

Fig. 6A. Attached stone. Cholecystogram showing a fixed filling defect in the body of the gallbladder.

CLINICAL FINDINGS

In all cases it has been hard to correlate the symptoms with the gallbladder findings with any accuracy. Several patients, however, have had symptoms definitely suggestive of gallbladder disease. A few cases were found on routine cholecystograms. Lund and Burman (16) reported a case in which symptoms of biliary tract obstruction were caused by a pedunculated papilloma. Preoperatively, cholelithiasis was suspected.

In the cholesterol polyp group, women predominate over men 8:1. The patients with papilloma, inflammatory polyp, arteriosclerotic vessel, and calculus were all women. The average age for all cases was 54 years.

RADIOGRAPHIC EXAMINATION

Although contrast media and roentgen technics have greatly improved through the years, there has been little change in the basic criteria that Kirklin (14, 15) set forth for differentiating polypoid lesions from gallstones. Our cholecystograms are obtained in the conventional manner, with Telepaque. A post-fatty-meal film and an upright film with a horizontal beam are routine. Examination is repeated in all suspicious cases. In addition, fluoroscopy is done and spot films are taken in the upright position.

Fig. 6B. Same case as Fig. 6A. Roentgenogram of the removed gallbladder filled with contrast medium and held erect.

The following diagnostic points are considered when attempting to identify polypoid lesions:

1. The concentration within the gallbladder is usually good.
2. The defect is smooth and either round or oval.
3. The size is usually less than 0.5 cm. and rarely greater than 1.0 cm.
4. There is no calcium.
5. There is no change in position on repeated examinations.
6. When there are two or more defects, their relationship remains constant on repeated examinations.
7. In the upright position, there is no movement of the defect.
8. Tangential views will show the attachment of the lesion to the gallbladder wall.

It is interesting that 9 of the 22 cases of fixed defects have been diagnosed within the last twelve months. This may be explained in part by improved technic. However, the Radiology Department and the referring physicians have recently been more alert to the possible existence of these lesions.

CONCLUSIONS

Fixed filling defects of the gallbladder are sometimes found during oral cholecystographic examination. Cholesterolosis is by far the commonest cause of polypoid lesions. The rarer possibilities are true papillomas, inflammatory polyps, attached calculi, and vascular defects.

With greater awareness, more of these lesions are being diagnosed on preoperative cholecystograms.

ACKNOWLEDGMENT: The author wishes to express his appreciation to Dr. John Pearce of the Department of Surgical Pathology for his assistance in reviewing the cases presented.

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SUMMARIO IN INTERLINGUA

Defectos Fixe In Le Pariete Del Vesica Biliari

Fixe defectos de replenation in le pariete del vesica biliari se vide non infrequentemente in cholecystogrammas oral. Es presentate un revista de 22 tal casos, incontrate inter 1952 e 1957. Le causa le plus commun de un fixe defecto de replenation—o de multiple tal defectos—esseva cholesterolosis. Altere causas esseva ver papilloma, polypos inflammatori, un extense vaso arteriosclerotic, e un calculo biliari affixate al pariete del vesica biliari.

Le sequente observationes suggere le presentia de lesiones polypoide: Bon concentration del substantia de contrasto intra le vesica biliari; un lisie defecto ronde o oval, usualmente con un mesura de minus que 0,5 cm e solo rarmente de plus que 1 cm; absentia de calcium; nulle alteration del position in repetite examines; nulle movimento del defecto in position erecte; e demonstration, in vistas tangential, de attachamento al pariete del vesica biliari.

The Radiographic Features of Tracheopathia Osteoplastica[1]

WILLARD J. HOWLAND, JR., M.D., and C. ALLEN GOOD, M.D.

TRACHEOPATHIA osteoplastica is a rare, benign tumorous condition of the trachea and major bronchi. The multiple osteocartilaginous tumors are formed in the wall of the trachea and project into the internal surface of that structure, producing a variable amount of obstruction to the airway. Solitary chondromas and solitary osteomas of the trachea usually are excluded from this particular category.

Apparently, the literature does not contain any detailed account of the radiographic features of this disease entity. It was felt advisable, therefore, to review roentgenograms of patients with this condition who had been seen at the Mayo Clinic. Also, we wish to present a case in which the diagnosis of tracheopathia osteoplastica was made on the basis of the clinical history and the characteristic radiographic picture as seen in tomograms.

REPORT OF CASE

CASE I: A 71-year-old white man registered at the clinic on Oct. 18, 1955, complaining of progressive exertional dyspnea and productive cough of three years duration. He also mentioned hoarseness, present intermittently for the previous eleven months. Ten months prior to his registration he had consulted a physician, who found roentgenographic evidence of a superior mediastinal mass compressing the trachea at and above the carina. Tomograms were interpreted as showing submucosal polypoid encroachment on the tracheal lumen. Bronchoscopic examination revealed extensive narrowing of the trachea, but results of biopsy were interpreted as negative. An eight-week course of irradiation to the mediastinum had produced temporary improvement, but for the three months prior to his registration at the clinic there had been further progression of the dyspnea and cough. Stiffness of the neck was said to have been present for thirty years.

Results of physical examination were normal, except for obvious respiratory embarrassment and severe limitation of motion of the neck. Laboratory procedures, including smears and cultures for acid-fast bacilli and cytologic examinations of the sputum for malignant cells, disclosed nothing abnormal.

Fig. 1. The thorax in Case 1. In spite of severe constriction of the trachea with partial obstruction of the airway, there is no definite roentgenographic evidence of emphysema.

The roentgenogram of the thorax is shown in Figure 1 and a tomogram of the trachea in Figure 2. It was decided not to carry out bronchoscopy because of difficulties associated with severe rheumatoid spondylitis and ankylosis of the cervical area of the spinal column.

A diagnosis of tracheopathia osteoplastica was made, and the patient returned home. Adrenal cortical steroid therapy was prescribed, and when he was last heard from, on Dec. 26, 1956 (almost fifteen months after admission), there was no indication of progression of his respiratory symptoms. After the patient's visit to the clinic, tissue was received that had been obtained for biopsy at the previous bronchoscopic procedure. This showed tracheal mucosa containing areas of noncalcified hyaline cartilage.

ADDITIONAL CASES

Search of the files of the Mayo Clinic has revealed 4 other cases of tracheopathia osteoplastica in which tomograms were available and the diagnosis was established by bronchoscopic examination. Three of these were previously reported by Carr and Olsen (1). Improved photographic

[1] From the Mayo Clinic and Mayo Foundation, Rochester, Minn. (W. J. H., Jr., Fellow in Radiology, Mayo Foundation; C.A.G., Section of Roentgenology, Mayo Clinic and Mayo Foundation). The Mayo Foundation is a part of the Graduate School of the University of Minnesota. Accepted for publication in April 1958.

Fig. 2. Tomogram of the trachea in Case 1. The narrowing of the trachea begins approximately 5 cm. below the vocal cords and extends into the major bronchi on both sides. The multinodular character of the tumor is well shown.

methods now allow us to reproduce the tomograms of those patients (Figs. 3 and 4).[2] In the fourth case minute, asymptomatic osteocartilaginous tumors of the trachea were noted during an examination of the throat, and the diagnosis was proved bronchoscopically, but tomograms do not show any evidence of the disease.

COMMENT

Gilbert and coworkers (2) were able to find a total of 546 cases of primary tracheal tumors in the literature up to 1955. Of the 503 lesions occurring in adults, about 50 per cent were benign, and the

[2] Cases 4,5, and 6 in the original report.

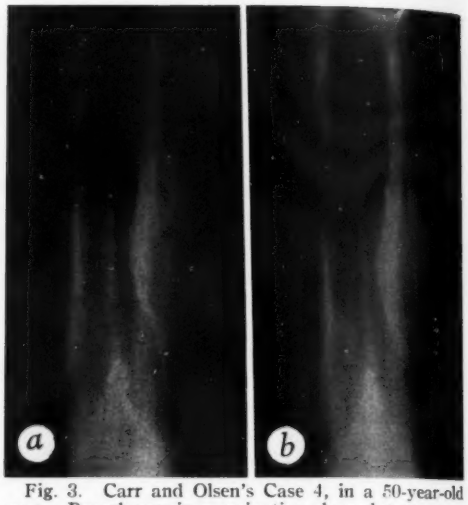

Fig. 3. Carr and Olsen's Case 4, in a 50-year-old man. Bronchoscopic examination showed tumors extending from 2.5 cm. below the larynx down into the main bronchi. *a*. Tomogram at 9 cm., showing multiple small, partially calcified nodules along the lateral walls of the trachea and the main bronchi. *b*. Tomogram at 10 cm., showing a small, partially calcified tumor projecting from the anterior wall of the trachea at the level of the carina.

predominating type of benign tumor was some form of osteochondroma (29.4 per cent). This included chondromas, osteomas, and tracheopathia osteoplastica.

Tracheopathia osteoplastica was first described by Wilks (3) in 1857. In 1947 Dalgaard (4) was able to discover about 90 cases in the world literature. He found no predominance of the disease according to sex; rather, it was evenly distributed among all age groups beyond the thirtieth year. He considered the typical early pathologic appearance to be chondro-osseous islands on the anterior or lateral walls of the trachea between the cartilaginous rings. Grossly, the tumors are primarily cartilaginous; calcification and ossification may or may not be present. After an extensive review of the hypotheses of the pathogenesis of this condition and pathologic studies of his own, Dalgaard concluded that "the elastic cartilage arises directly from the connective tissue through direct metaplasia, and this elastic cartilage has the ability to calcify and ossify, partly by means of osteoplastic activity."

This hypothesis has been accepted by other, more recent investigators. Most of the published reports are derived from necropsy studies, where the condition may have been encountered as an incidental finding. The disease also may produce sufficient respiratory obstruction to be the cause of death.

Although tracheopathia osteoplastica usually is considered to be a benign process with a limited potential for growth, the fact that it may be a precancerous condition is suggested in a recent paper by Dalgaard (5). His necropsy studies on 1 patient showed a metastasizing bronchogenic carcinoma primary in an osteochondromatous bronchus.

The typical roentgenogram of a patient with tracheopathia osteoplastica shows multiple flat nodular tumors involving the lateral and anterior walls of the trachea. These tumors may be well calcified, as seen in Figure 4*b*, but such calcification frequently is minimal, as in Figures 2, 3*b*, and 4*a*. We did not see any instance in which ossification as manifested by trabecular structure could be demonstrated roentgenographically.

Tracheopathia osteoplastica should be distinguished from defects caused by external pressure and from calcified paratracheal nodes, from carcinoma, and from papillomas and fibromas of the trachea. Roentgenographically, external-pressure defects usually are accompanied by a mass outside the trachea and the internal bulging defect is more likely to present a rounded contour. Carcinoma frequently will produce a more irregular narrowing of a shorter segment than is seen in tracheopathia osteoplastica. Papillomas and fibromas are rarely sessile, usually appearing round and discrete. Tomographic examination is necessary to demonstrate these differential points.

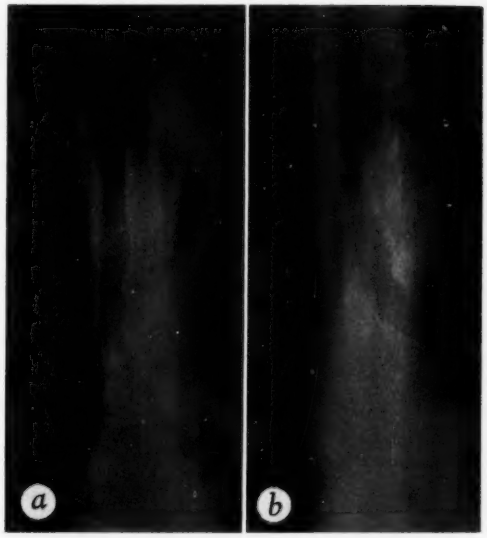

Fig. 4. *a*. Carr and Olsen's Case 5. Tomogram showing multiple cartilaginous tumors of the left wall of the trachea and left main bronchus and one tumor projecting from the anterior wall of the trachea. This 50-year-old woman experienced obstructive pneumonitis of a portion of the left lung as a result of narrowing of the trachea and left main bronchus. (Slightly retouched.) *b*. Carr and Olsen's Case 6. A partially calcified tumor is seen projecting from the right lateral wall of the trachea about 5 cm. above the carina. In addition, multiple plaque-like nodules project from the left lateral wall. This tomogram of a 56-year-old woman was made at the 8-cm. level.

SUMMARY AND CONCLUSIONS

1. The records of 5 patients with tracheopathia osteoplastica who underwent tomographic examination of the trachea and bronchoscopic proof of diagnosis have been studied. The record of 1 patient is presented in detail and tomograms of 3 others have been reproduced.

2. The radiographic features of tracheopathia osteoplastica reflect the pathogenesis and gross appearance of multicentric cartilaginous tumors involving the anterior and lateral walls of the trachea.

3. On tomographic examination tracheopathia osteoplastica has a characteristic appearance, showing multiple plaque-like tumors protruding into and involving a long segment of the trachea and main bronchi. These tumors may or may not contain roentgenographically demonstrable calcification. There was no roentgenographically visible ossification.

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SUMMARIO IN INTERLINGUA

Le Aspectos Radiographic De Tracheopathia Osteoplastic

Esseva studiate le dossiers de 5 patientes con tracheopathia osteoplastic in qui le trachea habeva essite examinate tomographicamente e in qui bronchoscopia habeva provate le diagnose. Le dossier de 1 patiente es presentate in detalio. Tomogrammas de 3 alteres es reproducite.

Le aspectos radiographic de tracheopathia osteoplastic reflecte le pathogenese e le apparentia macroscopic de cartilaginose tumores multicentric afficiente le parietes anterior e lateral del trachea.

In le examine tomographic, tracheopathia osteoplastic revela un apparentia characteristic: illo monstra multiple tumores de conformation plachettal que protrude in e affice un segmento longe del trachea e del bronchos major. Iste tumores pote sed non debe continer calcification de demonstrabilitate roentgenographic. Ossification de visualisabilitate roentgenographic non esseva incontrate.

Es a differentiar defectos causate per pression externe, per calcificate nodos paratracheal, per carcinoma, e per papillomas e fibromas del trachea.

Symposium on a Medical Reactor Installed at the National Naval Medical Center[1]

Introductory Remarks

CAPT. S. F. WILLIAMS, MC, USN

ONE MIGHT wonder as to the interest of the Navy Medical Corps in a nuclear reactor. It should be noted that this is a natural evolution in the general progress of the Navy toward nuclear power. The fact that the Navy was the pioneer, among the Armed Services, in transformation to this source of power is a matter of record. The sensational success of the submarine *Nautilus* demanded that other ships of the fleet be capable of superior performance. It is anticipated that, within a few years, all fighting ships, surface as well as submersible, will be converted to this type of propulsion.

This conversion brings with it greater problems not only for those interested in production, but also for our Medical Corps. We must be continually alert to possible hazards to personnel. It is obvious that the problems of protection must be even more accurately solved by those in this field, where weight and space are so important a factor. A man working in a compartment near a nuclear reactor must be more thoroughly protected and monitored than one ashore, who can depart from the scene of occupation to a less hazardous area.

In view of our limited experience in the field of neutron exposure, it seemed desirable that there be available at the National Naval Medical Center a neutron source from which further data might be gleaned. Since the establishment of the Radioisotope Laboratory at the Center in 1948 we have tried to sponsor new developments in the radioisotope field and much of the creative work has evolved from this interest, particularly through the personal efforts of Captain King, one of our essayists. The Laboratory at the Center, which he heads, is designated as the Navy school for training of radioisotope technicians and for residents in radiology who are completing requirements for their American Board certification. It was felt that a small medical type of reactor could serve a variety of purposes. For one thing, it could act as a training unit, since it is planned that we will eventually qualify both medical officers and technicians in reactor operation. Primarily, however, it would be a source of short-half-life isotopes which could be utilized in clinical medicine, since there is close proximity to clinical material. It would also provide a neutron source for study of the effect of neutrons on man and animals. We are indebted to many for their help in securing this unit. I might mention, in particular, Admiral B. W. Hogan, our Surgeon General.

The use of a reactor in the field of medicine, of course, is not new. One might cite the proximity of reactors at Brookhaven to medical facilities, or the Argonne National Laboratories. It is felt, however, that this is a milestone in that it is the first reactor operated for medical purposes only and by a hospital department. It is hoped that, as a result of this close liaison between new developments in the radioisotope field and clinical needs, rewarding knowledge will be gained with the aid of this reactor.

The papers which follow will describe the reactor in some detail and give a brief résumé of some of its applications to medicine. Since the reactor has been installed only recently, and experience with this particular unit is therefore limited, most of the work to be reported here is based upon use of a larger industrial reactor located at another center in Washington.

U. S. Naval Hospital
Bethesda 14, Md.

[1] Presented before the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

Physical Factors of a Low-Power Medical Reactor[1]

COMDR. THOMAS E. SHEA, MSC, USN, and LIEUT. ROBERT SHARP, MSC, USN

RELATIVELY low-power, homogeneous, solid-fuel reactors became available for training and familiarization during the year 1957. These reactors were intended for the training of scientific and engineering students, in a program of reactor technology being supported by the U. S. Atomic Energy Commission (A.E.C.). A type offered by the Aerojet-General Nucleonics Laboratories of San Ramon, Calif., the AGN-201, stimulated the interest of staff members of the Isotope Branch of the U. S. Naval Hospital, Bethesda, Md. The reactor was investigated and, when it was found to be intrinsically safe for operation in proximity to a hospital, the process of licensure and procurement was initiated.

The AGN-201 (Fig. 1) was designed to operate at 0.1 watt and, with the exception of the control console, was a unit package, including the shielding. In order to furnish medically useful isotopes, a minimum requirement of 3 and perhaps 5 watts of power was thought desirable. This higher power level, when authorized by the A.E.C., required some modifications of the 0.1-watt model. These modifications, chiefly reflected in the levels of instrumentation and increase in bulk shielding, were readily accomplished by the manufacturers.

The reactor, for which a twenty-year license has been issued to the U. S. Naval Hospital (Bethesda), is an integrated part of the isotope branch of the Radiology Service of the hospital. In addition to x-ray therapy, an extensive radioisotope service for both diagnosis and treatment is maintained. A nuclear casualty evaluation facility is under consideration. The reactor is expected to augment all of these.

The reactor is installed in a 21 × 21 × 21-foot air-conditioned concrete "blockhouse" type of building. With the console, it occupies most of the square footage of the building. "Cat-walks," graphite column, and building services occupy the cubic footage. To utilize the reactor products, a radiochemical laboratory is located in the adjacent building with access to the reactor room through an interlocking door. Conventional chemical laboratories and radionuclide counting and assay rooms are also in the adjoining building, as is the office and health physics section.

The characteristics of the reactor, reported by Biehl *et al.* (1) are as shown below. It must be noted, however, that Biehl's paper dealt with the 0.1-watt reactor and that power and flux levels have been adjusted for the 5-watt level at which we are licensed to operate.

Characteristics of the AGN 5-Watt Reactor

Power	5 watts
Thermal flux	2.25×10^8 n^t/cm.^{2}/sec.
Critical mass (Enriched UO_2)	3×10^3 grams U (6.5×10^2 grams)
Core size	25 cm. diameter; 24 cm. in height
Moderator	11×10^3 grams polyethylene
Reflector (graphite)	20 cm. wall
Shield	
Lead	10 cm. wall (7.5×10^3 lb.)
Water	55 cm. wall (8.7×10^3 lb.)
Concrete	450 cm. wall (6.5×10^4 lb.)
Temperature coefficient of reactivity (neg.)	2.5×10^{-4}° C.

The reactor with these characteristics (Fig. 2) is a unit fabricated with three concentrically located waterproof metal tanks. The *core tank* is the inner tank of aluminum, containing the uranium core or fuel and is small and located in the reactor center. The larger tank containing the reflector and gamma shield, entirely encapsulates the core tank; this is known as the *reactor tank*. The outer steel tank surrounding the other two is a leak-proof jacket containing the biological water

[1] From the Nuclear Medicine Branch, U. S. Naval Hospital, Bethesda, Md. Presented as part of a Symposium on The Nuclear Reactor Installed at the National Naval Medical Center, Bethesda, Md., at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

Fig. 1. The 5-watt reactor for medicine and research at the U. S. Naval Hospital, Bethesda, Md.

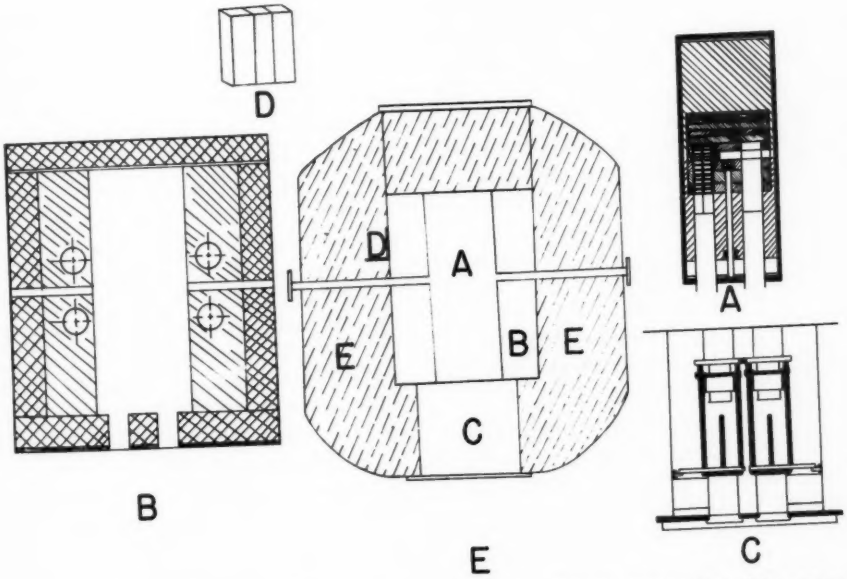

Fig. 2. Expanded view of the reactor components. A. Core tank with fuel disks and reflector. B. Reactor tank with reflector and lead shield. C. Safety and fuel rods. D. BF^3 ion chambers and rate meter for neutron detection. E. Biological shield water tank.

shield. An annular concrete block shield outside the water tank constitutes an additional biological shield.

The core tank contains the fuel: a stack of uranium-impregnated disks of polyethylene. This tank is bisected by

Fig. 3. Position and partial placement of the annular concrete biological shield necessary with a 5-watt power level.

the "glory hole," a 1-inch diameter aluminum tube for irradiation of samples. This tube is accessible from outside the biological shield for sample placement and calibration. In that portion that lies within the core the greatest neutron flux is obtainable for sample activation. The bottom disks of fuel are pierced for the insertion of fuel-tipped rods by means of which various power changes are obtained. The upper- and lower-half fuel disks are held together as a core by a thermal sensitive fuse. A rapid heat rise following an uncontrolled increase in neutron flux, or power excursion, will melt the fuse and cause the lower disks to fall, separating the core. This will insure a subcritical state and prevent the occurrence of a new excursion. Also, in this water- and gastight aluminum tank the fission products, both gaseous and solid, are contained. As a result of this design there can be no release of fission products to the atmosphere.

The core tank is enclosed by a steel jacket containing the reflector and gamma shield. Since this and the core comprise the elements of a reactor it is called the reactor tank. The graphite reflector that encapsulates the core is completely enveloped by a lead shield. The reflector, in which neutrons interact with carbon atoms, causes some neutrons to return to the core. The greater the percentage of return the greater economy of fuel and the higher the flux.

The lead shield about the reflector reduces to tolerance levels the radiation associated with the core. The radiation to be thus reduced is gamma radiation resulting from neutron interaction with hydrogen atoms of the moderator and the gamma emissions of fission products.

Four access ducts accessible from outside the biological shield pass through the reactor tank. These 4-inch diameter tubes are tangential to, but not within, the core, and are available for sample irradiation. To offset the large volume is a relatively low flux level available in these ducts when compared with the flux of the smaller glory hole.

A third waterproof tank, the largest, is the nominal outside wall of the 0.1-watt power level AGN reactor. This is a tank of water, with dissolved boric acid, completely surrounding the reactor or middle tank. It is principally for shielding purposes, but the large volume of water insures constant operating temperatures.

Water containing dissolved boron is the medium of choice for neutron shielding because of its neutron absorption. The bulk of the water provides gamma shielding, which is enhanced by the necessary distance that this interposes between the core and exterior, thus benefiting from the inverse square of the distance.

The reactor is designed to operate within a narrow range of temperature variation, approximately 13° C. A water jacket of these dimensions will be slow to respond to diurnal temperature change. When operated in an air-conditioned building, the water jacket should minimize temperature coefficient problems.

For the safe operation of the reactor at 5 watts, additional shielding is needed to keep the radiation level in the reactor control room below tolerance values. The installation of an 18″ thick annular ring of concrete blocks (Fig. 3) provides this additional biological shielding.

Inside the water tank are located flux-measuring BF_3 counters and boron-lined ion chamber neutron detectors. The flux-measuring ability of these instruments can be determined before each reactor start-up with neutrons provided by a 10-millicurie source of radium beryllium. This source is located external to the core in the graphite reflector. It also furnishes neutrons that are required from an external source to initiate a chain reaction, necessary to go to power with the reactor. It is by following the flux increase, as indicated on the rate meters and ammeters at the panel board of the console, that the operator can control the power level.

At zero power level a calculated portion of the uranium-polyethylene mass of the core has been removed. This results in a subcritical assembly, and no sustained flux level. A uranium-polyethylene mass equal to the portion removed is encapsulated in aluminum cans, of a size and diameter that permit controlled insertion, for the reconstitution of the core mass. The capsules of fuel are driven into the bottom half of the core assembly. Three of these fuel increments are connected to Fail-Safe circuits, which cause them to fall out of the core mass during an uncontrolled increase of flux. This is the second safety feature that reduces the core to a subcritical mass by gravitational force.

The speed of insertion of the fuel elements is controlled by the operator through manipulation of a mechanical-drive, electromagnetic coupling. The insertion of any portion of the fuel rods is indicated simultaneously on the ammeters and rate meter of the control board. This information enables the operator to add or withdraw fuel, thus to reach or maintain the neutron flux that is indicative of the power level desired.

The calibration method we use will simply be a comparison of activity produced in gold foils due to the unknown flux, compared with activation of those foils in a known flux. Elements with a large activation cross section for the (n, γ) reaction, whose products are radioactive, can be used in the shape of foils to detect thermal neutrons. The advantage of such foils is their insensitivity to gamma radiation (less than 6 MEV γ) and the small volume they occupy within a reactor. However, since foils must be removed from the reactor to be counted, they are not good for continuing flux measurements. Gold foils will be used for the calibration of this reactor, since gold is readily obtainable as a single stable isotope. From this isotope may be produced, by means of our uncalibrated flux, a countable gold (Au^{198}) isotope by means of the n, γ reaction. A similar countable gold isotope will be produced in a calibrated flux at the National Bureau of Standards (2). A comparison of absolute counts is a direct comparison of flux levels and will thus serve to establish the flux of our reactor.

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(*Pro le summario in interlingua vider le pagina 859*)

Neutron Activation Analysis[1]

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NEUTRON ACTIVATION analysis is a physical tool by which various elements may be quantitatively determined, often with an extreme degree of sensitivity. Hitherto, factors of cost and distance involved in securing a neutron source have apparently precluded extensive biologic usage but, with the more recent availability of smaller nuclear reactors, more extensive biologic investigation may be predicted.

The basic principles of neutron activation analysis might be briefly elucidated (1). A specimen, when placed in a reactor, is subjected to bombardment by thermal neutrons. The following scheme illustrates the resultant radiative capture (*n*, gamma) reaction:

$$ {}_{z}A^{M} + {}_{0}N^{1} \rightarrow {}_{z}A^{M+1} + \gamma $$

As an example, $Na^{23} + n \rightarrow Na^{24} + \gamma$. Na^{24}, an unstable isotope, then decays according to its usual scheme and, by virtue of its disintegrations, may be detected and quantitated. Thus the method is a twofold procedure; first, one induces radioactivity in a specimen by exposure to a neutron flux, and then the induced radioactivity is analyzed by the application of counting procedures to the radioactive emissions.

The amount of produced radioactivity may be calculated and is proportional to various physical characteristics of the involved element. There is a direct proportionality to the neutron flux of the source, the neutron capture cross section of the target nuclide, the mass of the isotope precursor irradiated, and the duration of irradiation. An absolute calculation for the produced activity may be inferred from the following formula:

$$ A = \frac{W\,(1.63 \times 10^{-5})\,(n)\,(\sigma_{Act})\,(f)\,(1 - e^{-\lambda t})}{At} $$

where A is activity in microcuries; W is weight of the particular element, in grams; n is the neutron flux; σ_{Act} is the neutron capture cross section in barns; f is the fractional precursor abundance; $1 - e^{-\lambda t}$ is the saturation factor for the produced nuclide; and At is the atomic weight of the element. By algebraic manipulation of this equation, the weight of the unknown element can be calculated on an absolute basis, assuming the activity is known. Exact determination of neutron flux proves difficult, however, and in practice it is more practical to irradiate a weighed standard at the same time, thus obviating several problems. No longer need the exact flux be known, nor the activity calibrated in microcuries; instead, a formula for relative counting is applied, and standard and unknown are counted in sequence, under the same conditions. Decay corrections are also circumvented.

$$ \frac{\text{Activity of unknown}}{\text{Weight of unknown}} = \frac{\text{Activity of standard}}{\text{Weight of standard}} $$

An obvious shortcoming of this technic may be immediately noted; neither hydrogen, carbon, nitrogen, oxygen, sulfur, nor iron can be analyzed, because of the failure to produce countable quantities of radioisotopes from these elements. Material suitable for such determinations is nonetheless wide, and is, in most instances quite sensitive (see page 857).

The calculations are based upon a neutron flux of 2.5×10^{8} (as obtainable in the AGN-201 nuclear reactor) and are expressed in grams. It should be noted that the time required for 95 per cent

[1] From the Nuclear Medicine Branch, Department of Radiology, U. S. Naval Hospital, Bethesda, Md. Presented as part of a Symposium on The Nuclear Reactor Installed at the National Naval Medical Center, Bethesda, Md., at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

The opinions expressed herein do not necessarily reflect those of the United States Navy.

Sensitivity in Grams

Element	*One Hour Activation*	*Saturation Activation*
Sodium	2.3×10^{-5}	1.0×10^{-6}
Potassium	2.6×10^{-4}	1.4×10^{-5}
Calcium	5.0×10^{-4}	5.0×10^{-4}
Iron	7.7×10^{-1}	4.6×10^{-4}
Magnesium	1.8×10^{-4}	1.8×10^{-4}
Manganese	4.3×10^{-7}	1.0×10^{-7}
Copper	1.0×10^{-6}	5.1×10^{-7}
Zinc	1.5×10^{-5}	8.6×10^{-6}
Arsenic	2.1×10^{-5}	4.3×10^{-7}
Selenium	8.6×10^{-6}	4.3×10^{-7}
Chlorine	9.4×10^{-6}	6.4×10^{-6}
Iodine	6.2×10^{-7}	4.5×10^{-7}
Bromine	2.1×10^{-6}	4.5×10^{-7}
Phosphorus	1.9×10^{-3}	1.0×10^{-6}

saturation (five half-lives) is prohibitive in the case of isotopes of iron and phosphorus (220 and 70 days). About half of these isotopes have very short half-lives, and necessitate a reactor in immediate proximity to separation and counting equipment; otherwise decay precludes any analysis.

Once a biologic specimen is irradiated, it must be remembered that all ions present will become activated, in varying degrees. In marked contrast to prior industrial applications of this technic, wherein most often a single impurity has been sought, biologic materials involve many elements, and analysis therefore becomes considerably more complex. Activation of a biologic specimen results in the production of a variety of radioisotopes, of markedly differing concentrations and activities, and masking of the emissions is the natural consequence. Thus, while the process of activation is a simple one, requiring minimal preparation of tissue or specimen, analysis of the radioisotopes produced may undo such attendant simplicities.

Our experience with neutron activation analysis[2] has been largely limited to gamma-counting procedures, and with this technic there is probably but one biologic element which is amenable to direct and simple analysis. That element is the ubiquitous sodium, present in all biologic materials, which is, by virtue of 100 per cent fractional precursor abundance, large neutron-capture cross section, and short half-life, quite easily activated. In specimens of extracellular material, sodium can be directly analyzed, without further preparation. In fact, if a sample of extracellular fluid is allowed to decay for several hours after activation, sodium is the only isotope evidenced by gamma-ray spectroscopy. To underline the magnitude of this preponderance, we have seen that two hours after activation of $CaCO_3$, known to contain 0.5 per cent sodium, a pure Na^{24} spectrum is obtained. Sodium 24 is thus quite capable of masking other emissions, and can, by itself, make other identifications impractical. From these features of sodium, several problems become immediately apparent: (*a*) Analysis for sodium should be easy and accurate. (*b*) Analysis for other ions in the presence of sodium necessitates the relatively complete removal of that ion, if analysis by gamma counting is to be performed. With regard to the former, rapid and accurate determinations of serum sodium have proved possible as illustrated by the following data (2):

Serum Sodium (mg.)

Photometric	*Activation*	*Difference* (%)
16.3	16.5	1.2
20.8	20.3	2.4
25.9	26.3	1.5
30.1	29.7	1.3
30.4	30.1	1.0
32.5	32.9	1.2

We have recently investigated the applicability of this technic to bone sodium (3) and have found it equally feasible. In this instance, a 40:1 gradient of calcium: sodium makes ordinary flame photometric methods inapplicable but does not interfere with activation technic, because of the very short half-life of calcium 49 (the only isotope of calcium produced in significant quantities). Thus it might be expected that sodium analyses in the most

[2] Courtesy staff of Nuclear Reactor Project, Naval Research Laboratory, Anacostia, Maryland.

difficult and minute situations should prove possible. Yet, with the relative ease and availability of flame photometry, activation analysis will prove to be required only rarely.

Other biologic ions do not share this ease of routine determinations and, particularly with the trace elements, analytic methods are often difficult. Calculations of neutron activation yields give countable values for zinc, copper, manganese, and magnesium in biologic material, and such methods might offer promise in the analytic methodology.

As previously mentioned, with gamma counting, because of the interference of other ions (*e.g.*, sodium), certain preparatory measures become essential prior to counting. (*a*) Sodium must be removed in most situations, especially with extracellular fluid specimens. (*b*) Depending upon the element sought, its concentration, and ability to sustain activation, an appropriate fraction, free from other radioactive ions, must be isolated. For longer half-lived isotopes, the second criterion may be simplified by simple decay. In blood, P^{32} will be essentially the only source of activity remaining after a period of four days is allowed for decay. Only bromine, copper, sodium, and potassium remain after a matter of several hours. But the determination of magnesium, manganese, zinc, and chlorine require isolation into appropriate fractions, preferably prior to activation, because of their very short half-lives.

In order to remove sodium from solution, we have adopted the technic of ion-exchange columns, utilizing Dowex-50 cation exchange resin, from which sodium may be eluted at a higher *p*H than other cations. Studies with Na^{24} and K^{42} have revealed a cross contamination of less than several parts per thousand with this method (4). Even less contamination of divalent fractions is to be anticipated, since they are eluted at a substantially lower *p*H than is potassium. Previous attempts to remove sodium by precipitation, and the reverse operation, that of precipitating the desired components from solution, free from sodium, have proved unsuccessful. Although we are as yet without such experience, it might be anticipated that anion exchange resins could likewise give sodium-free mixtures of the desired anions.

Beta-counting technics have been used in conjunction with neutron activation. Measurements of tissue Na, K, and P have proved possible (5), as has estimation of the tissue distribution of gold (6). The use of differential absorption may prove valuable in distinguishing between beta emissions of sufficiently different strength, as with Na^{24} and K^{42} and thus allow direct analysis without the necessity of ion separation.

Other biologic investigations of neutron activation analysis have included studies on strontium and barium (7), manganese (8), and iodine (9). In all of these studies, carrier chemical separation of the desired elements proved necessary following activation.

SUMMARY

A discussion of the principles, technics, and limitations of neutron activation analysis, as applied to biologic material, is presented. The difficulties of isotopic discrimination by means of gamma analysis are discussed, with particular reference to the problem of Na^{24}. Preliminary results with regard to analysis are mentioned.

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SUMMARIO IN INTERLINGUA

Analyse De Activation Neutronic

Le analyse del activation neutronic es un methodologia physic que permitte le determination quantitative de varie elementos, in multe casos con extreme grados de sensibilitate. Le principios, technicas, e limitationes del methodologia es discutite in su application a materiales biologic. Tal materiales contine multe elementos, e lor activation resulta in le production de un varietate de isotopos de marcate differentias in concentration e activitate, e occultation del emissiones es un consequentia natural. Le experientia del autores se ha concentrate principalmente super technicas de gamma-contation. Le difficultate del discrimination isotopic per iste medio es discutite, specialmente con respecto al problema de natrium 24. A causa del interferentia per iones ab iste origine, le elimination de natrium ante le analyse es necessari in le majoritate del situationes.

Secundo que qual elemento es cercate e secundo que qual concentration e qual capacitate de esser activate es characteristic de illo, un appropriate fraction del elemento, libere de altere iones radioactive, debe esser isolate. Iste requirimento pote esser simplificate in le caso de isotopos a plus longe periodos vital per profitar del disintegration.

SUMMARIO IN INTERLINGUA

Factores Physic De Un Reactor Medical A Basse Potentia

(*Pagina 852*)

Es describite le reactor de 5 watt que esseva recentemente installate al Statounitese Hospital Naval a Bethesda, Maryland, pro le objectivos del roentgenotherapia e del production de isotopos. Iste reactor representa un modification del modello AGN-201 del "Aerojet-General Nucleonics Laboratories" a San Ramon, California, que esseva planate pro un functionamento a 0,1 watt.

Le reactor at Bethesda consiste de tres tanks de metallo in disposition concentric. Le tank al centro contine le combustibile in le forma de discos de polyethyleno impregnate de uranium. Un tank reactor enveloppa le tank central e contine le reflector de graphite e le protector anti gamma. Un tank exterior de aciero contine aqua como protection biologic. Un anulo protectori de blocos de cemento al exterior del tank de aqua forni protection biologic additional.

The Production and Medical Applications of Short-Half-Life Radioisotopes[1]

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MUCH OF THE early clinical work with radioisotopes was performed with short-half-life isotopes produced by a particle accelerator. Since the application of the high-flux nuclear reactor, most clinicians prefer utilizing materials of longer half-life. This is due to the fact that relatively few medical installations are in the vicinity of a nuclear reactor and also that longer-half-life isotopes can be kept available for a greater length of time.

The growing concern regarding the increasing exposure of our population to ionizing radiation dictates that, among other things, an effort be made to decrease the body radiation dose received during diagnostic radioisotope studies. One method that might partially achieve this would be to substitute radioisotopes of shorter half-life for those now in common use. I^{131}, Cr^{51}, S^{35}, and As^{74} might, for example, be thus replaced. The construction of reactors in the immediate vicinity of a hospital would allow clinical applications of these short-half-life materials, which are now impossible.

Our hospital is fortunate in obtaining one of the first, if not the first, purely medical reactor. This has been described in a preceding paper.[2] Our discussion will be limited to the production of radioisotopes in the low-power reactor, problems associated with production and separation of these radioisotopes, and plans for their clinical utilization.

PRODUCTION OF RADIOISOTOPES IN A LOW-POWER MEDICAL REACTOR

The activity of any radioisotope that can be produced by the neutron gamma reaction, which is the only practical nuclear reaction for such a reactor, depends upon several factors. These are:

1. *Flux*, measured in units of thermal neutrons/cm.^{2}/second. This factor is related to the power of the reactor and is dependent upon the fuel and its arrangement. The value is characteristic of each reactor. The flux in the center of the "glory hole" of the Bethesda Naval Hospital reactor is in the order of 2.5×10^8.

2. *Neutron capture cross section*, the probability of neutron capture by the target atoms. It is expressed in "barns," each of which is 1×10^{-24} cm^2.

3. *Number of target atoms introduced*, determined by the mass of the element introduced and its atomic weight. The mass limitations depend upon the excess reactivity of the reactor, the size of its irradi-

TABLE I: PRODUCTION OF RADIOISOTOPES BY A 5-WATT REACTOR

(A list of those produced in millicurie amounts at saturation time)

Na^{24}	Sr^{87}	Ce^{143}
P^{32}	Y^{90}	Eu^{152m}
A^{40}	Nb^{94}	Tb^{160}
Se^{46}	Zr^{97}	Dy^{165}
Cr^{51}	Ru^{103}	Ho^{166}
Mn^{56}	Pd^{103}	Yb^{169}
Co^{60}	Rh^{104}	Tm^{170}
Cu^{64}	Pd^{109}	Yb^{175}
Zn^{69}	Ag^{108}	La^{177}
Ga^{70}	In^{116m}	Ta^{181}
Ga^{72}	Sb^{122}	Re^{186}
Ge^{75}	Sb^{124}	W^{187}
As^{76}	Sn^{125}	Re^{188}
Br^{80m}	I^{128}	Os^{191}
Br^{80}	Cs^{134}	Ir^{192}
Br^{82}	Ba^{139}	Ir^{194}
Kr^{83m}	La^{140}	Au^{198}
	Ce^{141}	Th^{233}
	Pr^{142}	U^{239}

[1] From the Nuclear Medicine Branch, U. S. Naval Hospital, and Department of Nuclear Medicine, U. S. Naval Medical School, Bethesda, Md. Presented as part of a Symposium on The Nuclear Reactor Installed at the National Naval Medical Center, Bethesda, Md., at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

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[2] Shea and Sharp, page 852.

ation ports, or glory holes, and the capture cross section of materials inserted.

4. *Irradiation time.* No correction need be made if the time is equal to the saturation time, which is about 5 half-lives of the daughter product (resultant radioisotope). If the irradiation time is less than saturation time, the formula must be corrected by a factor of $(1\text{-}e^{-\lambda t})$, where λ is the decay constant of the resultant radioisotope and t is the irradiation time expressed in the same units of time as the half-life of the resultant product.

Utilizing these factors we arrive at the production formula:

$$A = N\sigma fS \tag{1}$$

where

A = Activity produced
N = Number of atoms of the target material offered for irradiation
σ = Neutron capture cross section, in barns
f = Thermal neutron flux
S = Saturation factor

The number of atoms to be irradiated may be represented by:

$$N = \frac{6.02 \times 10^{23} \times M}{At} \tag{2}$$

where

M = mass of target nuclide in grams
At = atomic weight of the target element.

In cases where the irradiation time equals the saturation time, S equals 1 and, since our result is to be in microcuries, we have:

$$A = \frac{\frac{6.02 \times 10^{23}}{At} \times M \times \sigma \times f}{3.7 \times 10^{4}} \tag{3}$$

With the 5-watt reactor which we are discussing (the AGN-201-M), the flux in the center of the glory hole has been determined to be 2.5×10^{8} neutrons/cm.^{2}/second (1).

The limit of excess reactivity has been established at 0.2 per cent, and it has been determined that more than 2×10^{24} barn gram atoms will reduce the excess reactivity by this value (1). Therefore, target material equivalent to more than 2×10^{24} barn gram atoms will "poison" the reactor by removing the excess reactivity that is required for a self-sustaining chain reaction. Thus, it is obvious that there is a limit to the amount of material that one can irradiate without the poisoning effect; this limit is given in Formula 2 above. Assuming that this maximum amount of target material is irradiated, Formula 2 becomes:

$$2 \times 10^{24} = \frac{6.02 \times 10^{23}}{At} \times M \tag{4}$$

Assuming the cross section is 1 barn and S equals 1, and inserting these values into Formula 3, we have:

$$A = (2 \times 10^{24})\left(\frac{2.5 \times 10^{8}}{3.7 \times 10^{4}}\right)(10^{-24}) \tag{5}$$

$$A = 1.35 \times 10^{4}\ \mu c$$

This is the total radioactivity it is possible to produce in the 5-watt reactor, assuming the above conditions.

Now if Formula 2 is re-inserted for the value of 2×10^{24} barn gram atoms:

$$1.35 \times 10^{4}\ \mu c = (2.5 \times 10^{8}) \times \left(\frac{6.02 \times 10^{23}}{At}\right) \times M \left(\frac{\sigma \times 10^{-24}}{3.7 \times 10^{4}}\right) \tag{6}$$

$$M = \frac{At}{\sigma} \times 3.3 \tag{7}$$

where σ = capture cross section for the nuclide in barns.

Thus, for any given stable isotope, one can immediately determine the maximum weight in grams that can be irradiated and still allow enough reactivity to produce a self-sustained chain reaction.

The final formula used to determine the production of radionuclides in this reactor, for an irradiation period equal to the saturation time, becomes:

$$A = \frac{(4.07 \times 10^{27})\ (M)\ (\sigma)}{At} \text{ in microcuries} \tag{8}$$

where σ = activation cross section for the target nuclide in cm.^{2} The values for At and σ may be obtained from any table of the nuclides; M may be obtained from Formula 7.

If the natural element is irradiated instead of a pure stable isotope, correction must be made in Formula 8 for the abundance of the target stable isotope in the element.

By applying Formula 8, a list of radioisotopes is obtained (Table I) that can be produced in millicurie amounts at saturation time. Many of these are not practical. With Co^{60}, for instance, twenty-five years of continuous operation would be required to produce this amount. The maximum activity was determined for several interesting radionuclides that can be produced in usable quantities. These are listed in Table II.

As may be noted, there are many factors that determine the production of radionuclides in a low-power reactor, and these must all be considered in evaluation of a reactor for medical application. An additional point should be borne in mind. The above production capabilities, as listed, are for the glory hole. The reactor also contains access ports, which will contain ten times the mass that can be irradiated in the glory hole at one-third the specific activity of glory hole production (1). Thus, for I^{128} the total activity that can be produced in the glory hole is 12,000 μc with a specific activity of 220 μc/gm. In the access ports an additional 40,000 μc of I^{128} can be produced. It is thus possible to produce up to about 52 mc of I^{128} in a saturation time.

The thermal column may also be used for production of radioisotopes, although no figures are yet available for the yields of this type of irradiation. Theoretically, large masses of target material could be exposed over a long period of time without appreciably altering the excess reactivity of the reactor.

PREPARATION OF CARRIER-FREE AND HIGH-SPECIFIC-ACTIVITY RADIOISOTOPES

Although millicurie amounts of many radioisotopes can be produced in the 5-watt reactor, such production may prove impractical. The saturation time production of isotopes with half-lives over twelve hours would require continuous operation of the reactor for sixty hours or more. This greatly intensifies problems relative to availability of trained and licensed reactor operators and supervisors. We do not plan to work our operators in shifts longer than four continuous hours, which would mean six different shifts every twenty-four hours. Consequently, saturation time production would, in most instances, be limited to radioisotopes with half-lives not exceeding a few hours.

After production, the greatest problem is that of separation. Referring to Table II, one notes that all the isotopes produced are of very low specific activity. With Na^{24} as an example, the specific activity for one hour irradiation period is 4 μc/gm. and after a seventy-five hour period (saturation) it is only 94 μc/gm. A small tracer dose of such specific activity could probably be administered safely as NaCl or another suitable salt. With K^{42} or Ca^{64}, however, the stable carrier at such specific activity would be toxic. A dose of Cu^{64} for a brain tumor positron scintiscan (1.9 mc) would require 10 gm. of stable copper, a dose which could not be safely administered parenterally. Also, an irradiation period in the order of sixty hours would be needed.

Thus, it is apparent that the radioisotopes as produced in a 5-watt reactor require further treatment to separate the unstable from the stable materials. The following are some of the procedures that can be utilized in such separations. These procedures involve nuclear or "hot-atom" chemistry and a complete discussion is beyond the realm of this paper. Only superficial treatment will be assigned to this subject.

The Szilard-Chalmers Process: As stated, the reaction occurring in production in this reactor is the (n, γ) reaction. In this process the γ recoil is usually powerful enough to sever the bonds holding the recoiling (radioactive) atom in the molecule.

TABLE II: RADIOISOTOPES AVAILABLE FROM A 5-WATT REACTOR, PHYSICAL FACTORS

Radioisotope	Half-life	Emission	One Hour Production		Saturation Production		Mass (gm.)
			μc	μc/gm.	μc	μc/gm.	
Na^{24}	15h	β^-, γ	740	4.2	14,000	93	150
Mg^{27}	9.6m	β^-, γ	1,200	1			1,260
Cl^{38}	37.5m	β^-, γ	38	10	56	15	3.7
A^{41}	1.83h	β^-, γ	3,800	17	11,500	51	213
K^{42}	12.5h	β^-, γ	25.6	0.3	470	7.2	65
Mn^{56}	2.58h	β^-, γ	3,720	230	13,500	985	13.7
Cu^{64}	12.8h	β^-, β^+, γ	605	10	9,150	171	53
Zn^{69}	13.8h	β^-, γ	22	0.1	440	2	202
As^{76}	26.4h	β^-, γ	280	4.5	13,200	220	60
Sr^{87}	2.8h	β^-, γ	230	1.0	1,490	5.9	250
Zr^{97}	17h	β^-, γ	18	.01	1,290	0.77	1,670
I^{128}	25m	β^-, γ	11,000	175	12,900	220	63

These radioisotopes have been selected as they can be produced in usable activities and are of interest in biological studies. Saturation time production equals about five half-lives. Mass is obtained from the formula $M = \frac{3.3\,At}{\sigma}$.

In the original experiment, using a radium beryllium source, Szilard and Chalmers irradiated ethyl iodide and, after irradiation, shook the organic compound in an aqueous reducing solution. This separated a large amount of the free I^{128}, which was nearly carrier-free (3). This technic is still used to prepare I^{128}.

Requirements for a successful Szilard-Chalmers procedure are as follows:

1. The chemical bond energy equivalent should be low enough that it is exceeded by the energy produced by internal conversion. This allows the newly formed unstable ion to break loose. This most often occurs with compounds that are electrovalent (electrolytes) and occurs less often with covalent compounds.
2. The unstable atom must not reform with the molecular fragment from which it was separated.
3. There must be a chemical method of separating the produced unstable atoms from the target compound.

A group of interesting compounds now under study for application of this process are the phthalocyanine pigments. Metallic compounds of these dyes are available for Na, K, Cu, Be, Mg, Ca, Zn, Cd, Ba, Al, Sn, Pb, V, Cr, Mn, Fe, Co, Ni, Pt.

We have investigated the copper compound, which is a bright blue pigment. This pigment is dissolved in a small amount of concentrated H_2SO_4 and irradiated in a polyethylene container or may be irradiated as a dry powder. Following irradiation, water is added, which precipitates out the copper phthalocyanine and allows the ionic copper to go into the dilute H_2SO_4 phase or, if the dry compound was irradiated, into the water phase. This is removed by pipetting, or by a separatory funnel. The original dye contains 17 per cent copper as determined by activation analysis. The yield of Cu^{64} obtained by our laboratory was 50 per cent. The remaining phthalocyanine compounds are under investigation, and it is anticipated that a simple and practical method of obtaining several carrier-free radioisotopes may evolve.

The production of Mn^{56} by irradiating $KMnO_4$ has also been studied in our laboratory. Here the principle is the same but the technic differs. The $KMnO_4$ is irradiated as a water solution at about neutral *p*H. The Mn^{56} is released from the molecule and immediately forms $Mn^{56}O_2$ by the oxidizing action of the parent compound. Manganese dioxide is insoluble in the aqueous $KMnO_4$ and can be removed by filtration. The yield can be as high as approximately 100 per cent.

Other compounds that are soluble in organic solvents and insoluble in water have been tried in this procedure. These include ethyl iodine, ethyl chloride, and such compounds as dimethyltin, tripheuyl-

arsine, dimethyl zinc, and tetramethyl silicone. With the exception of the first two compounds, the yield of this group tends to be low.

Chromatography and Ion Exchange Procedures: As a rule, a water-insoluble compound, when irradiated, may have the daughter radioactive ion removed by water extraction. In some instances solubility coefficients, *p*H, or other factors may make such separation difficult. In these cases the compounds may be passed over a suitable ion exchange column and the radioactive ions removed by the resin. The ions may then be eluted from the resin by passing solutions of controlled *p*H over the resin.

In general, the most important use of ion exchange columns is in the separation of different ions, such as in the removal of contaminants and unwanted ions. Thus, if in the process of irradiating or preparing a sample a contaminant such as sodium were introduced into the previously described copper phthalocyanine procedure, the Na^{24} could be removed by ion exchange.

Paper chromatography likewise is best suited to separate ions or atoms of different elements. The direct application of these two principles to prepare high-specific-activity or carrier-free radioisotope-stable isotope mixtures is limited.

APPLICATION OF SHORT-HALF-LIFE RADIOISOTOPES

It should be apparent that only a few technics using short-half-life radioisotopes have been tried up to this time. Uses for Na^{24} and K^{42} have been described in many previous papers. However, very few institutions are able to carry out continuous studies using these two radioisotopes, due to their short half-lives (Table II). Air-express shipments of Na^{24} and K^{42} arrive on Monday night or Tuesday morning and undergo almost complete radioactive decay by Thursday of the same week. A hospital with its own medical reactor would have a constant source of these two radioisotopes.

The same holds true of Ga^{72}, with a 14.1 hour half-life, and Cu^{64}, with a 12.8 hour half-life. Also, there are numerous radioisotopes with half-lives of two days or less for which no clinical application has been sought because they have not been available for evaluation. We will briefly discuss the clinical application of some of these by-products.

Short Half-Life I^{128}: Some investigators have believed that a thirty-minute radioiodine uptake study would suffice as an adequate parameter of thyroidf unction (5).

Iodine^{128} has a twenty-five-minute half-life. Our laboratory is evaluating a thyroid clearance technic, similar to that described by Berson *et al.* (5), that involves an intravenous dose of I^{128} and external *in vivo* measurements over the heart, thyroid, and urinary bladder at the thirty-minute interval. These measurements are corrected for radioactive decay by simultaneous comparison with a standard dose of I^{128}. The patient then is given the routine tracer dose of I^{131} and twenty-four hours later the regular "thyroid battery" of tests is performed, which includes the twenty-four-hour I^{131} thyroid uptake, the conversion ratio, the saliva-PBI ratio, and the chemical PBI. Thus, we will be able to compare results of the short, thirty-minute *in vivo* study with a group of tests that have been satisfactorily evaluated. If acceptable, the thirty-minute thyroid clearance will be used as a "screening" test to eliminate euthyroid patients from further studies with I^{131}.

The short half-life of I^{128} also allows studies on the same patient at relatively brief intervals (three or four hours). The effects of many drugs and environmental conditions upon thyroid function can be studied under controlled conditions by running a base-line study on an individual, administering the test drug and repeating the thyroid study later in the day. Such repeated studies can be performed at intervals of four hours or more until the desired results have been achieved.

Short-Half-Life Cu^{64}: Our laboratory has been using Cu^{64} in positron scintiscanning for brain tumor localization (6). Thus far, the Cu^{64} has been shipped from the Oak Ridge National Laboratory in 100-millicurie lots every Monday. Cu^{64} versenate is prepared and administered Tuesday afternoon, and by the time of utilization there is usually about 10 mc of labeled versenate available, or enough for three patients. With Cu^{64} available from a medical reactor, patients with suspected brain tumors can be studied at any time. In the past, many candidates were not studied, as no positron-emitting Cu^{64} was available. Cu^{64} also localizes in the liver soon after administration. Evaluation of positron scintiscanning of the liver is now under way. This study is an attempt to locate and estimate the size of liver lesions.

Blood-Volume Studies: The most applicable, practical, and accurate method of blood-volume determinations at this time involves the use of erythrocytes labeled with Cr^{51}. No satisfactory explanation has been offered as to why Cr^{51} should label the red blood cell constituent any better than other metallic radioisotopes. Attempts have been made in our laboratory to label the red cells with Cu^{64} and, while this is possible, the uptake, to date, has been limited to 30 per cent and the elution rate is more rapid than for Cr^{51}. Consequently, patients who have had simultaneous blood volume determinations with Cr^{51} and Cu^{64} give about a 10 per cent higher volume for the latter technic. Further attempts are under way to utilize Cu^{64} as well as Mn^{56} and other short-half-life radioisotopes for blood-volume studies.

Isotopic Dilution Studies: Determinations of the Na^{24} and K^{42} spaces are already accepted procedures. By the application of neutron activation analysis it is hoped that serum sodium and potassium levels can be obtained and used with the above space studies to furnish data on total exchangeable sodium and total exchangeable potassium.

A hospital reactor would have an immediate supply of Cl^{38}, which has a thirty-minute half-life. Thus, chlorine 38 space studies could be performed, and changes in this space noted, by repeat studies made after influences by environmental factors or pharmaceutical agents. The passage of the chloride ion through membranes and tissues could be studied.

Another application of Cl^{38} would be the determination of the serum chlorides. This could be obtained by adding a small amount of Cl^{38} (1 or 2 microcuries) to a sample of the patient's serum and precipitating the serum chlorides with an inadequate amount of $AgNO_3$. The total figure for serum chlorides is about 1 mEq/10 ml. of blood in the normal individual, so that 0.5 mEq of $AgNO_3$ could be added to the serum of 10 ml. of blood. The Cl^{38} in the precipitate is counted:

$$\frac{\text{C/m of } Cl^{38} \text{ in ppt.}}{\text{c/m of } Cl^{38} \text{ added to serum}} = \frac{\text{ratio of chlorides pptd.}}{\text{total serum chlorides}}$$

Since 0.5 mEq of $AgNO_3$ was added, 0.5 mEq of chlorides were precipitated, and *mEq of chlorides pptd* = mEq of total serum chlorides in the blood sample times the ratio of $\frac{Cl^{38} \text{ pptd.}}{\text{total serum chlorides}}$.

This same type of isotopic dilution study could be used to determine the amount of other electrolytes in the blood, urine, or other tissues, providing a method of selective chemical separation of these electrolytes were available.

TISSUE RADIATION DOSE DELIVERED BY SHORT-HALF-LIFE RADIOISOTOPES

The substitution of short-half-life products for those with a longer half-life that are now in use in clinical medicine will decrease the tissue radiation dose delivered to the patient. This is a primary purpose of using the shorter-half-life radioisotopes.

On the basis of formulae previously published (7), the following assumptions

must be made in estimating the radiation dose delivered to a tissue:

1. The organ or tissue cannot distinguish between different radioisotopes of the same element.

2. The administered radioisotope is uniformly distributed through the mass of tissue which is being considered. The size of the tissue or organ is great enough to absorb all beta particles.

3. The excretion rate is such that the effective half-life equals the physical half-life.

4. The distribution (or uptake) of the radioisotope by the tissue under consideration is immediate.

A comparison between the radiation dosage in rads delivered to the thyroid by I^{131} and I^{128} will be calculated as an example. The gamma ray dosage is a negligible amount, and is not included.

$$D_B = 73.5\,\bar{E}_B \times T1/2 \times C$$

D_B = dose in rads delivered to the tissue after complete decay of the radioisotope

$\bar{E}_B$ = average beta ray energy in MEV

$T1/2$ = effective half-life (equals physical half-life in this instance)

C = concentration of the radioisotope in microcuries per gram of tissue

I^{131}: $D_B = 73.5 \times 0.187$ MEV $\times$ 8 days = 110 rads/microcurie/gram of thyroid

I^{128}: $D_B = 73.3 \times 0.770$ MEV $\times$ 0.0173 days = 1 rad/microcurie/gram of thyroid

According to these calculations, the dose delivered to the thyroid is 110 times greater for I^{131} than for I^{128}. However, the gamma-ray emission of I^{128} is only 7 per cent of all emissions and has an energy of 0.43 MEV. I^{131} has a complicated gamma-ray spectrum with about 100 per cent of emissions resulting in gamma rays and energies of the principal rays of 0.637 and 0.364 MEV. The dosage delivered at a distance of 1 meter by 1 millicurie of I^{131} as a point source in air is ten times that of I^{128}. From a practical standpoint, the tissue radiation dose to the thyroid from equivalent activities based on gamma-ray emission will be twelve times larger for I^{131} than for I^{128}. This example demonstrates the ability to reduce the radiation dosage to a patient by administering radioisotopes with half-lives shorter than those isotopes now in general use.

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SUMMARIO IN INTERLINGUA

Le Production E Le Applicationes Medical De Radio-Isotopos A Curte Periodos De Medie Valor

Le production de un radio-isotopo in un reactor nuclear depende del section de choc del neutrones in le material de scopo, del fluxo del reactor, e del tempore de irradiation. Le activitate que on pote producer depende etiam del massa total del material de scopo que pote esser irradiate, e isto de su parte es determinate per le excesso de reactivate del reactor.

In le reactor AGN-201-M, functionante a 5 watt con un fluxo de $2{,}5 \times 10^8$ n/cm^2/sec e un excesso de reactivitate de 0,2 pro cento, le sequente radio-isotopos con curte periodos de medie valor pote esser pro-

ducite in quantitates que se mesura in millicuries: Na^{24}, Cu^{64}, As^{76}, Zr^{97}, Pd^{108}, W^{186}, Re^{194}, Ir^{142}. Le periodo de medie valor de iste isotopos es 12 a 30 horas. Radio-isotopos a plus curte periodos de medie valor que es producite in millicuries es: Mg^{27}, A^{41}, Mn^{56}, $Kr^{83}n$, Sr^{89}, $In^{166}n$, I^{28}, Ba^{138}, Dy^{165}. Iste isotopos pote esser producite sin contamination per altere radio-isotopos del mesme elementos.

Le applicabilitate clinic de multes de iste radio-isotopos ha non ancora essite evalutate. Radio-isotopos como Na^{24} e K^{42} es ben cognoscite. Cu^{64} pote esser usate in le localisation de tumores cerebral. Le uso de I^{128} in un test del function thyroide, requiriente 30 minutas, es currentemente sub evalutation. Un radio-isotopo a curte periodo de medie valor que poterea prender le placia de Cr^{51} in determinationes del volumine de sanguine se trova sub investigation.

The AGN-201-M Reactor Thermal Column[1]

COMDR. F. W. CHAMBERS, JR., MSC, USN, and LIEUT. J. W. DUCKWORTH, MSC, USN

IN ADDITION TO its primary value for clinical use, the AGN-201-M 5-watt reactor provides a potentially valuable tool for biological research. The proposed increase in use of nuclear propulsion by the Navy has presented environmental problems that require evaluation. These problems fall into two categories. One concerns the routine peacetime radiological safety problem, since more and more Navy personnel will be exposed to the mixed ionizing radiation associated with reactors. The other problem is the possible necessity of increasing the exposure above normally accepted limits in time of war to improve the functional and operational use of our equipment. One of the main reasons for the limited amount of information available in these fields has been the lack of reactors for medical use.

The extent to which the thermal column can be used for biological experiments is not known at the present time. Numerous studies must be made to determine how the ratios of the several types of radiation might be changed, what the spectral distribution of the various radiations would be under these circumstances, and what effect the presence of these various systems plus biological specimens of different sizes in the thermal column might have on the reactivity of the reactor.

The thermal column is a large tank 34 inches in diameter and 24 inches deep. Flux measurements have been made in the tank, with and without a 4-inch lead shield, when it contained either water or graphite. Since the bottom of the thermal column is separated from the core by only 10 inches of graphite, even at the low 5-watt power level a useful neutron flux is available at the top of the column. Therefore, investigation of the biological effects produced by extended exposure to low neutron dose levels would appear feasible. The large cross-sectional area of the column might accommodate test animals up to the size of small swine. Calculations would indicate that near-lethal neutron doses are available when the animals are placed near the bottom of the tank if suitable exposure conditions can be provided within reactivity requirements for a critical condition of the reactor.

Some approximations, based on a limited amount of information, have been made with respect to the available flux for the various radiations at different levels in the tank under certain conditions. They are presented in Figure 1.

If the thermal column is loaded with graphite alone, the thermal neutron distribution might be shown by Curve I, the fast neutron distribution by Curve IV, and the gamma distribution by Curve III. If the bottom 4 inches of the graphite column were replaced by lead, the distribution might be shown by Curve II for thermal neutrons, Curve IV for fast neutrons, and Curve VII for gammas. If the graphite in the second case is replaced by water, one might expect a distribution as shown by Curve V for thermal neutrons, Curve VI for fast neutrons, and Curve VII for gammas.

The problem of maintaining sufficient reactivity for criticality has also been investigated on the basis of the limited information available. The initial fuel loading of the reactor with an empty glory hole provides approximately 0.2 per cent excess reactivity. Placing a polyethylene slug in the glory hole will double the excess reactivity. Removing a wooden slug from an access port, which would simulate removing the same amount of water

[1] From the Naval Medical Research Institute, National Naval Medical Center, Bethesda, Md. Presented as part of a Symposium on The Nuclear Reactor Installed at the National Naval Medical Center, Bethesda, Md., at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

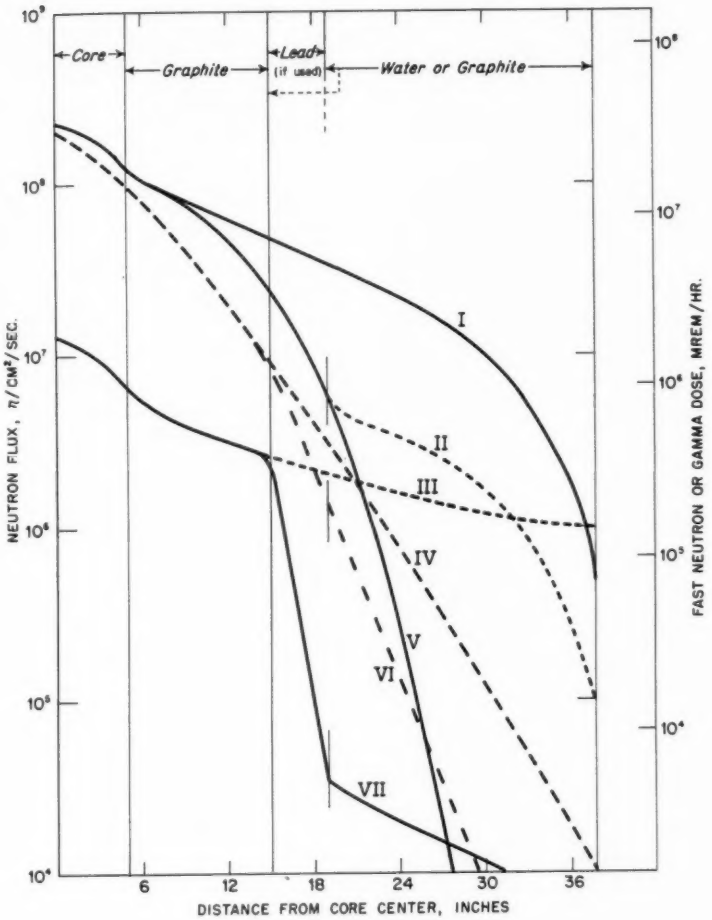

Figure 1.

from the thermal column, removes approximately 0.003 per cent excess reactivity. By comparing the volumes of the wooden slug and the thermal column water, it may be estimated that a void in the thermal column would reduce the excess reactivity by approximately the same amount that might be gained by addition of a polyethylene slug in the glory hole, thereby leaving the normal excess reactivity approximately the same.

One further problem might be the effect of the rapid change in position of a relatively large animal placed in the thermal column. The effect might be one which would vary the excess reactivity, thereby causing the reactor to scram. However, the importance function in this instance is estimated to be low enough that it could be controlled by adjustment of the fuel rods.

In summary, the determination of the flux and energy distribution under various conditions within the thermal column will involve considerable effort. The extent to which the loading of the thermal column may be varied without seriously affecting the criticality of the reactor must be investigated. Since the effect of a rapid change in position by an animal in the thermal column could make it difficult to maintain power level and cause scrams,

studies must be made starting with small animals to determine how large an animal might be successfully irradiated within the thermal column. In spite of the possible problems involved, we believe the radiations in the thermal column of this reactor will provide a valuable tool in biological research.

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SUMMARIO IN INTERLINGUA

Le Columna Thermal Del Reactor AGN-201-M

Le columna thermal del reactor AGN-201-M de 5 watt al National Centro Medical Naval a Bethesda, Maryland, es un grande tank de un diametro de 34 pollices e un profundor de 24 pollices. Mesurationes de fluxo ha essite facite in le tank, con e sin un carapacio de 4 pollices de plumbo, quando illo contineva aqua e quando illo contineva graphite. Proque le fundo del columna thermal es separate ab le nucleo del reactor per solmente 10 pollices de graphite, mesmo al basse nivello de 5 watt de potentia, un utile fluxo de neutrones es disponibile al capite del columna. Le investigation del effectos biologic resultante de prolongate expositiones a basse nivellos de dosage neutronic esserea per consequente practicabile. A causa del grande area de su section transversal, le columna esserea capace a albergar animales experimental usque al dimensiones de micre porcos. Un graphico monstra le disponibile fluxo pro varie radiationes a differente nivellos intra le tank sub certe specificate conditiones.

Numerose problemas remane a solver, sed le opinion pare justificate que radiationes in le columna thermal del reactor va provider methodos de valor in recercas biologic.

A Camera Utilizing the Polaroid Land Process for the Reproduction of Roentgenograms as Transparencies for Projection[1]

DAVID B. HAYT, M.D., and JOHN A. EVANS, M.D.

THE ACCURATE and clear reproduction of a roentgenogram of good quality as a print or a transparency presents a problem because of the wide tonal range, from completely black to almost entirely transparent, with many intermediate shades of gray, some of which are inevitably lost in the photographing of the film to produce a negative and the rephotographing of the negative to produce a projection positive or a print. A poor roentgenogram is even more difficult to reproduce well. Good quality lantern slides, therefore, are usually the province of the professional medical photographer, who readjusts the contrast of the slide and lightens or darkens specific portions of the film with viewboxes containing multiple lights or by other methods, often taking many days for completion of the task.

With the advent of Polaroid Land Projection Film a very satisfactory photographic medium has been found for obtaining slides of professional quality from roentgenograms in a few minutes. This film has an extraordinary ability to reproduce accurately the large number of intermediate gray tones of the typical roentgenogram, a wide exposure latitude, a sharp fine grain, thin emulsion that does not "pop" out of focus on extended projection, and great sensitivity. The process produces a finished transparency mounted and ready for projection in about five minutes. Some manipulation of contrast may be secured by variation of exposure and development. The film at present comes in two sizes, for making 3 1/4 × 4-inch (standard lantern slide size) and 2 1/4 × 2 1/4-inch eight-exposure rolls, and is mounted in light-weight snap-together binders for projection. If desired, glass mounts can be used for greater protection.

Fig. 1. The camera and stand.

The purpose of this article is to describe the application of a photocopy camera for the production of lantern slides from roentgenograms on Polaroid Land Projection Film. The authors have tested the pilot model and collaborated later in designing and experimenting with the production prototype of this camera.[2]

The unit consists of a bellows-type view camera mounted on a rigid frame with an

[1] From the Department of Radiology, The New York Hospital-Cornell Medical Center, New York, N. Y. Accepted for publication in April 1958.

[2] The production model will be manufactured by Fairfax Photo Products, Inc., Fort Lee, N. J.

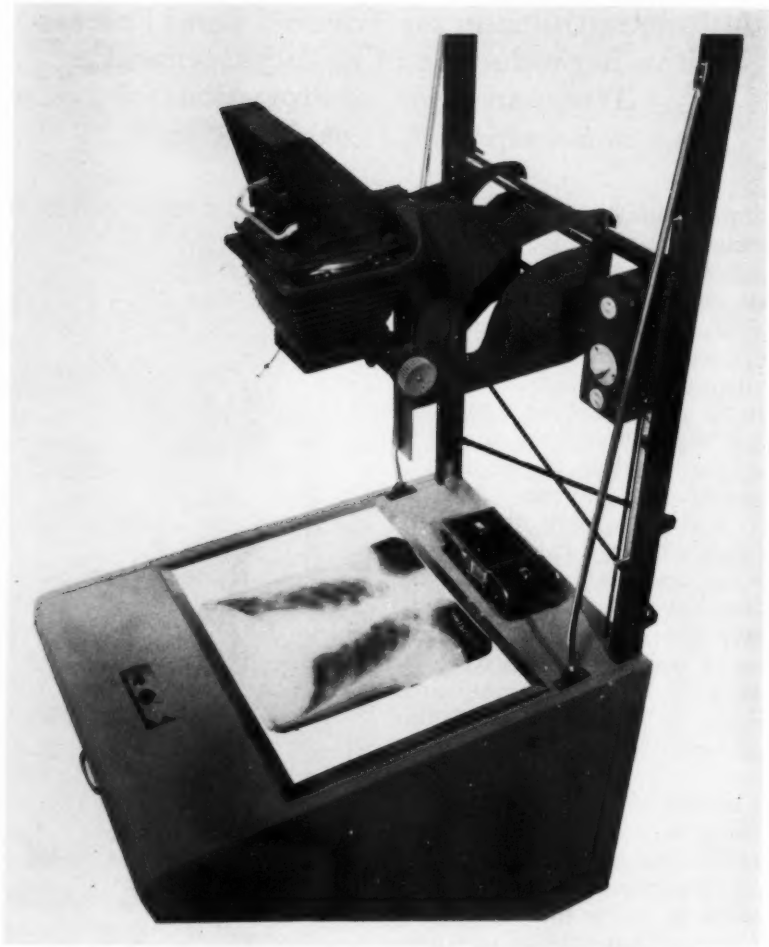

Fig. 2. A roentgenogram in place on the viewing box and the camera in position for focusing.

electrically driven vertical elevating mechanism attached to a stand containing a high-intensity viewbox. It accepts and develops the 3 1/4 × 4-inch Polaroid film but may also be used with conventional sheet and roll film. Focusing and composing are done on a ground glass which is viewed at eye level by means of a 45-degree mirror. The camera may also be turned horizontally and the mirror pivoted out of the way for copying wall charts, or for copying four or more films at one time from a conventional viewbox, or photographing patients. The lens has a F127 mm. focal length with shutter speeds from 0.01 to 1.0 second and apertures from f4.5 to f45. The viewbox measures 17 × 22 inches for the copying of one complete 14 × 17-inch roentgenogram or two 11 × 14 inches or smaller, and is evenly illuminated by six fluorescent lights. Two 14 × 17-inch roentgenograms may be copied on one slide by the use of supplementary lenses and a double exposure, with a shift of the camera laterally between the two exposures. Appropriate masks are supplied. The minimum field which can be taken is 1.5 × 1.25 inches so

that enlarged views of small areas on the films can be made to fill the whole slide. Plus two diopter and minus two diopter supplementary lenses are utilized for further magnification and for copying two 14 × 17-inch roentgenograms on one film. An audible timer is included to time the developing, and a locking cabinet for the accessories is supplied. The electrical system of the camera locks as well. Accessories which are contemplated are overhead lights for copying of charts, gross specimens, etc., and a kit to enable the film to be cut into four pieces for mounting in 35-mm. (2 × 2 inches) projectors after photographing four roentgenograms on one large film.

For determination of exposure, a Weston Master III exposure meter is used. The meter reading is taken on a section of the film considered representative of the middle tones of the roentgenogram, and multiplied by the exposure factor necessitated by the magnification encountered in close-up photography.

RESULTS

The quality of the reproductions is approximately equal to professionally produced 3 1/4 × 4-inch slides and is considerably better than most 35-mm. and amateur transparencies in accurately duplicating the full range of tones found in a technically good roentgenogram. By varying exposure and development time, some degree of improvement in reproducing films of substandard technic can be accomplished for the purposes of projection. For best results it is suggested that the production of slides be assigned to one individual, since a certain amount of skill is acquired through experience in operating the machine. In the Department of Radiology of the New York Hospital the chief radiographic technician assumes this responsibility.

The actual labor time per slide, from the time the roentgenogram is placed on the illuminated glass until the finished transparency is mounted and ready for projection, is ten minutes. When several slides are to be made at one time, only about six minutes per slide is required, due to overlapping of the various steps. The cost of each film plus plastic mount is $0.56. Since a certain number of errors will be made, especially at first, the actual material cost per finished slide will approximate $1.00.

In addition to the use of the transparencies for the illustration of lectures, a major application at the New York Hospital has been the presentation of films to a large number of people in attendance at certain of the conferences, such as Surgical Grand Rounds. The list of cases to be presented is given to the Department of Radiology the night before the conference; the films are located, sorted, and discussed, and the most significant are made into slides for projection the next morning.

Other suggested uses are the developing of a teaching file of slides from the x-ray museum, and Polaroid reproductions by the hospital or private radiologists so that copies may be retained of films sent to other institutions or physicians.

The cost per slide would preclude the storage of reduced size x-ray reproductions by this method in place of the roentgenograms themselves unless a considerable number were photographed on one film. Some diminution in quality would then be expected.

For illustrating publications, the ordinary Polaroid black and white print film has not proved satisfactory in our experience. However, a new film for commercial use (4 × 5 inches) may soon become available and may provide satisfactory publication prints. The Polaroid transparency negative may also be removed in the dark, fixed in ordinary fixer, and used to make prints on conventional enlarging paper.

With the addition of overhead incandescent lights serviceable lantern slides have been made of opaque printed material, such as history summaries, charts, and graphs.

Excellent copies have also been made of 35-mm. Kodachrome transparencies on the

3 1/4 × 4-inch Polaroid transparency film. This is of value for the lecturer who has standardized his slides in the 3 1/4 × 4-inch size, and has one or two Kodachromes which he wishes to reproduce in the larger size in black and white.

Although this method of transparency production offers advantages in quality and rapidity of results, as well as fairly low cost and convenience, it does require a camera which takes up about six square feet of floor space, and it is stressed that some degree of experience in its operation is necessary for best results. The cost per slide of nonprofessional 35-mm. transparencies is less, but the quality is inferior.

Though there has been no degeneration of the photographic image during the six-month period in which the slides have been used at The New York Hospital, a scum has on occasion formed on the surface of the films about twelve hours after they have been made. This scum is easily removed with carbon tetrachloride but may prove embarrassing to the lecturer if the slide is not inspected after this period and prior to projection. Steps are being taken by the Polaroid Corporation to correct this condition.

SUMMARY

A camera for the production of high quality 3 1/4 × 4-inch lantern slides on Polaroid Land Transparency Film from roentgenograms has been presented, and its advantages, disadvantages, and applications discussed. It appears to produce excellent standard institutional size transparencies from roentgenograms in a short period of time.

ADDENDUM

A smaller model utilizing an ordinary Polaroid camera without ground glass viewing or focusing, has been tested recently and found to produce acceptable reproductions of roentgenograms although it is not quite as versatile as the larger machine.

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SUMMARIO IN INTERLINGUA

Un Camera Que Utilisa Le Processo "Polaroid Land" Pro Le Reproduction De Roentgenogrammas In Le Forma De Transparentias Pro Le Projection

Un camera es describite que produce placas de projection (3 1/4 × 4 pollices) ex pellicula de transparentia Polaroid Land ab roentgenogrammas. Le qualitate del reproductiones attinge approximativemente le standard del production professional de placas de projection de 3 1/4 × 4 pollices e es considerabilemente superior a illo del majoritate de transparentias de 35 mm e de altere transparentias de production non-professional ab le puncto de vista del duplication accurate del complete scala de tonos que es trovate in technicamente bon roentgenogrammas. Le tempore de labor pro un placa, incluse le reproduction e le montage, es circa dece minutas.

Rotational Scanning of the Liver[1]

DAVID E. KUHL, M.D.

When intravenous Au^{198} or rose bengal-I^{131} is removed from the blood by normal liver tissue, tumors will be demonstrated as defects on the liver scan pattern only if their presence sufficiently affects the counting rate of the scintillation counter. The liver is a solid organ which resembles an irregular hemisphere, having been so molded by surrounding structures that at least half its bulk is curved laterally along the right side of the patient in contact with the ribs. In one-plane scanning of a supine patient, the recorded image emphasizes the left side of the liver. Unfortunately, tumor identification is made difficult in this region by easy confusion with normally occurring liver defects such as the gallbladder fossa, the hilus, and the fissure for the round ligament, all of which can be consistently demonstrated on the photorecording. Nor are defects in the more homogeneous large right lobe demonstrated well, for, as the probe traverses it, the curvature of

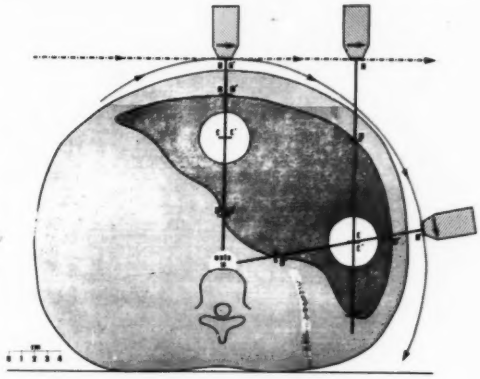

Fig. 1. Comparison experiment of planar (A-A) and rotational (A′-A′) scanning. Cross-section diagram of realistic liver phantom viewed from above. I^{131} solution is displaced by two "tumors," one in the anterior liver and the other in the right lobe. The "tumor" in the right lobe is more effectively scanned with the rotational path.

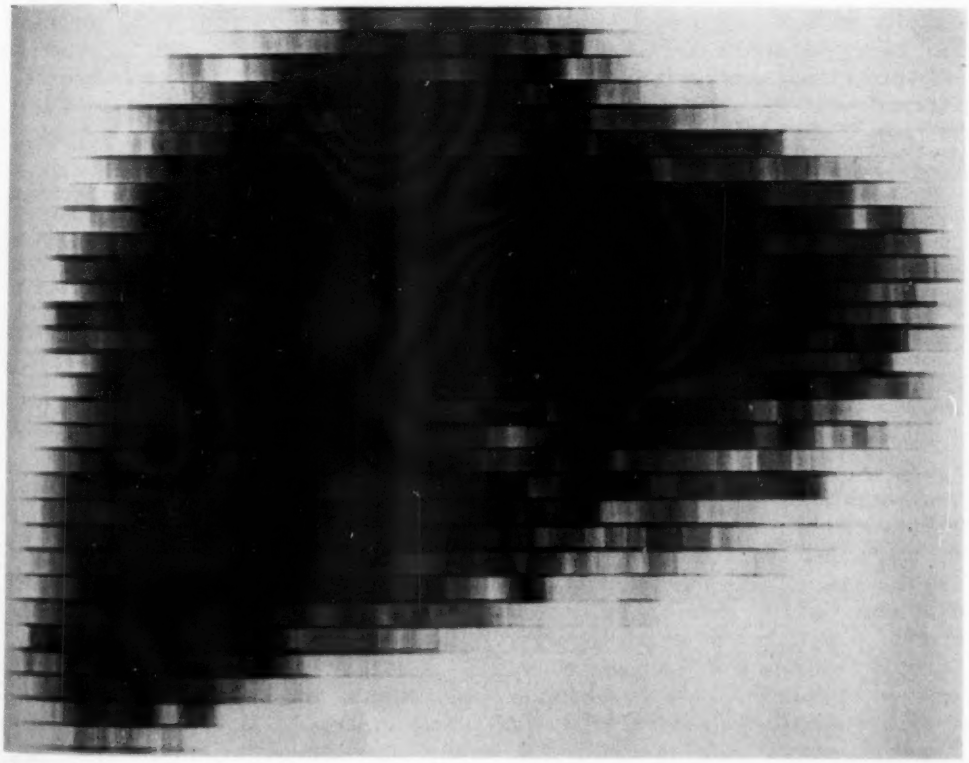

Fig. 2. Photorecording from planar scanning of phantom. Only the anterior "tumor" is well demonstrated. Compare with Fig. 3 on following page.

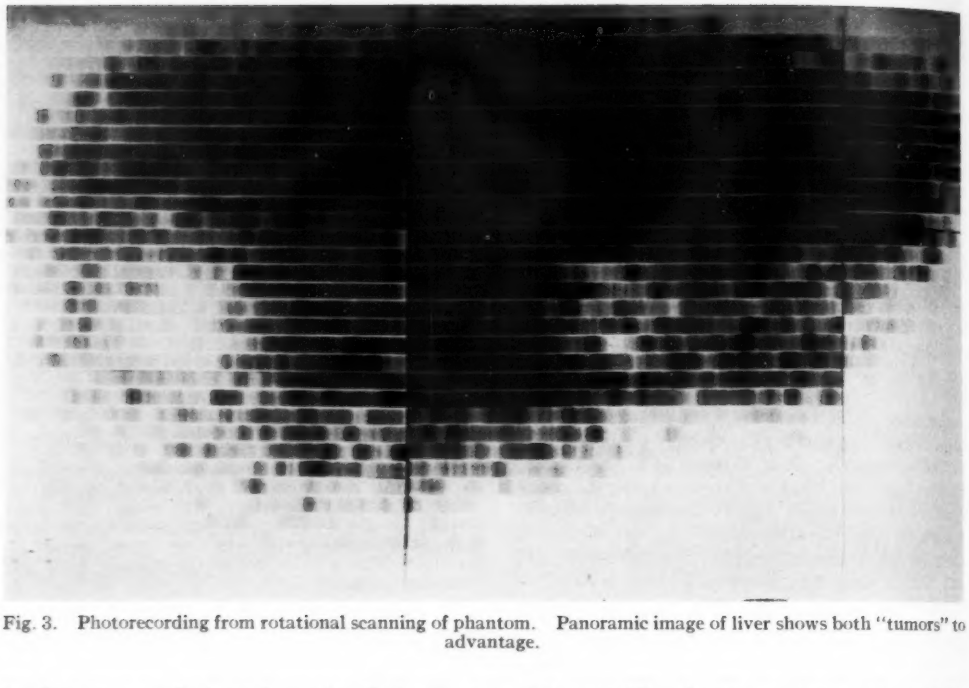

Fig. 3. Photorecording from rotational scanning of phantom. Panoramic image of liver shows both "tumors" to advantage.

the liver mass results in an increasing displacement of the surface from the detector and the lobe is actually viewed on edge with maximum thickness. As a consequence, small tumors in the posterior right lobe are masked by the thick intervening layer of liver tissue and may escape detection. To a certain extent, this difficulty might be avoided by making multiple planar scans in anterior, oblique, and lateral views, but this would be time-consuming, would require repeated dosage if rose bengal-I^{131} were to be used, and each recording would show only a limited region of the liver to advantage.

In seeking to refine this study, it became apparent that rotational scanning might be employed to advantage. If, instead of scanning in one plane, the detector were to traverse the upper abdomen in semicircular path, with the probe focused continuously on the anterior border of the vertebral column, the collimator would be held as close as possible to the liver surface at all times and a more uniform thickness of liver tissue would be examined throughout the scan (Fig. 1). The maximum volume of the liver would thus be brought within the range of effective scanning.

Experimental studies with a realistic liver phantom have confirmed the validity of this hypothesis. What would be a deeply placed lesion from a frontal planar view now becomes a shallow lesion as the detector rotates laterally. Tumors of the right lobe are scanned with greater effectiveness, increasing the probability of their detection, and yet the left lobe is surveyed just as adequately as with planar scanning (Figs. 2 and 3). A panoramic image of both liver lobes is presented on a single recording.

Preliminary investigations suggest that rotational scanning may be a definite improvement of the liver survey technic meriting further development.

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[1] From the Department of Radiology, Hospital of the University of Pennsylvania, and the William H. Donner Center for Radiology, University of Pennsylvania, Philadelphia, Penna.

EDITORIAL

The Intervertebral Disk

The studies of the spine by Schmorl during the late twenties and early thirties did much to clarify the role of the intervertebral disk in relation to spinal lesions and their symptomatology. The spine is probably unique in its degree of functional activity. Not only does it support the weight of a large portion of the body, but it is the fulcrum for most of the other moving parts. The movements of the spine and its buffer effect in absorbing bodily shocks are largely dependent upon the intervertebral disks. The elasticity and plastic adaptation of the disks are therefore of tremendous functional importance. Any changes such as dehydration and fibrosis associated with senescence will inevitably be of structural and functional significance.

From a gross anatomical standpoint the disk consists of a fibrous ring, the annulus fibrosus or lamellosus, composed of a series of concentric lamellae enclosing the nucleus pulposus and attached to the adjacent vertebrae by thin plates of hyaline cartilage. The nucleus stands out distinctly in young persons, but with age the point of division becomes much less well delineated. Physiologically, the disk is a complex structure of living tissue which has important bodily functions. It is first a connecting link and stabilizer of adjacent vertebrae. It is also a shock absorber, receiving the pressure of shocks and strains and distributing them evenly over the surface of the vertebra. It is, in addition, the structure which permits and controls the bending and torsion activities of the spine and body.

The various components of the disk have distinct functions. The cartilaginous end plates not only attach the disk to the vertebral body but the intact plate prevents damage to the cancellous vertebral structure by pressure of the nucleus pulposus. The nucleus pulposus, on the other hand, acts as a fluid ball bearing which transmits pressure equally in all directions and permits maximum bodily movement. The main function of the annulus fibrosus is to serve as a strong capsule for the nucleus pulposus and to act as a cushion to help distribute shocks and pressures evenly. Beadle (1), working in Schmorl's laboratory, has done much to correlate the anatomy and physiology of the disks.

Relatively few studies have been made of the fluid content and other properties of protruded disks which may play a role in causing or permitting protrusion. In a recent study Hendry (2) directs attention to the fluid content of the nucleus pulposus. He quotes Sylvén to the effect that the nucleus consists of a three-dimensional lattice of collagen fibrils in which is enmeshed a mucoprotein gel. As a result of his own studies, Hendry feels that hydration of the nucleus is predominantly due to imbibition pressure of this gel and not to osmosis. The degree of imbibition was determined both by direct measurement of imbibition pressure and by saturation and weight increase methods. A lowered affinity for fluid was found in all cases of protruded disk irrespective of the patient's age. This change appeared to have preceded the mechanical protrusion, however short the clinical history, because no operative specimen approached a normal degree of hydration. The commonly accepted view that disk protrusion is caused by or contributed to by hyperhydration of the disk is thus incorrect. The disk may absorb more fluid when removed from the body but is unable to

retain it in the body when under increased pressure.

Hendry believes that reduction of the imbibition pressure of the nucleus will have three effects: (*a*) A greater proportion of the total strain will be thrown on the annulus. (*b*) The character of the strain may change from alternating tension and compression to unrelieved compression. (*c*) Under conditions of prolonged relaxation the disk will imbibe fluid but will be unable to retain it when stress is reapplied. The first two factors may cause attrition of the annulus. The third factor will, under the influence of strain, cause a rapid loss of tissue fluid and a rapid redistribution of hydrostatic pressure. These three factors, it is believed, provide in themselves a satisfactory explanation for most of the phenomena associated with disk protrusion.

One factor, and perhaps the most important one in lesions associated with the disk, is the aging process. Beadle states that the spine is the first organ in the body to undergo degenerative changes. He believes this to be related to the far-reaching change of function in man when he assumed the upright posture. The studies of Coventry, Ghormley, and Kernohan (3) indicate that the disk is at a point of maximum efficiency during the third decade of life and that thereafter there is a steady progression of degenerative processes. They, along with others, found the most pronounced degenerative changes in the sixth decade. At this time defects in the cartilage plates are frequent, thus contributing to the formation of Schmorl's nodes. Degeneration of the annulus also occurs. The annulus was found to be broken posteriorly in numerous cases in this decade. The nucleus blends with the annulus and is almost completely converted to fibrocartilage. Many specimens show the nucleus as a mass of amorphous material often containing small plaques of calcium which are visible only under the microscope.

The work of Hendry is of interest, adding further information on an important subject. The question arises, however, whether the fluid content and pressure in the nucleus are the most important causative factor in disk protrusion. Senescent changes must be accorded considerable prominence in the etiology of this and other lesions of the disks and spine. It must be remembered that by the sixth decade the nucleus has lost most of its fluid content and thereby most of its plasticity. Under these conditions the disk narrows and secondary bone reaction develops as a protective mechanism. The end-result of this is loss of function and the development of degenerative disease of the spine.

REFERENCES

1. Beadle, O. A.: The Intervertebral Discs: Observations on Their Normal and Morbid Anatomy in Relation to Certain Spinal Deformities. Medical Research Council, Special Report Series, No. 161. London, His Majesty's Stationery Office, 1931.

2. Hendry, N. G. C.: The Hydration of the Nucleus Pulposus and Its Relation to Intervertebral Disc Derangement. J. Bone & Joint Surg. **40-B:** 132–144, February 1948.

3. Coventry, M. B., Ghormley, R. K., and Kernohan, J. W.: The Intervertebral Disc: Its Microscopic Anatomy and Pathology. J. Bone & Joint Surg. **27:** 105, 233, 460, January, April, July 1945.

ANNOUNCEMENTS AND BOOK REVIEWS

NINTH INTERNATIONAL CONGRESS OF RADIOLOGY

As announced earlier, the Ninth International Congress of Radiology will be held in Munich, July 23 to 30, 1959. A Radiology Flight Committee, represented by Dr. Jean Pakter, Dr. Egon G. Wissing, and Dr. Arnold L. Bachman, has planned to arrange special flights to the Congress, as follows:

1. Leave New York, Idlewild Airport, for Frankfurt or Munich, not later than July 21, 1959; returning from Paris, Orly International Airport, four weeks later.
2. Leave New York, Idlewild Airport, for Frankfurt or Munich, not later than July 21, 1959; returning from Rome, Ciampino West International Airport, five weeks later.
3. Leave Boston, Logan International Airport, for Frankfurt or Munich, not later than July 21, 1959; returning from Paris, Orly International Airport, four weeks later.

The round-trip fare for the flight is $295.

Though it is quite possible that space will no longer be available by the time this notice appears, it is suggested that anyone interested communicate with Dr. Wissing (VA Hospital, South Huntington Ave., Boston 30) concerning the Boston flight, or Dr. Pakter (Personal, Room 917, New York City Department of Health, 125 Worth St., New York 13) concerning the New York flight.

Attention is also called to the Commercial Exhibit to be held in connection with the Congress. More than eighty exhibitors from fourteen countries will present a comprehensive cross section of the current state of radiological technology and related fields. Information concerning the Exhibit may be obtained by application to The Committee for the Industrial Exhibition, Hamburg 1, Mönckebergstr. 7.

LOS ANGELES RADIOLOGICAL SOCIETY MIDWINTER CONFERENCE

The Eleventh Annual Midwinter Radiological Conference, sponsored by the Los Angeles Radiological Society, will be held at the Statler Hotel, Los Angeles, Calif., on Saturday and Sunday, Jan 31 and Feb. 1, 1959.

An outstanding program of pertinent interest has been arranged. Guest speakers will be: Dr. Peter Kerley and Professor D. W. Smithers, of London, England; Dr. F. N. Silverman, Cincinnati, Ohio; Dr. A. Finkelstein, Philadelphia, Penna.

The conference fee of $20.00 includes two luncheon meetings featuring questions and answers. A banquet ($7.50 per plate) preceded by cocktails will be held Saturday evening. Reservations may be made through Dr. Chester P. Bonoff, 1930 Wilshire Blvd., Los Angeles 57, Calif.

Courtesy cards will be available to residents in radiology and radiologists in the Armed Forces by advance registration, with reduced tariff for the luncheons and banquet. Hotel reservations should be made promptly through the Convention Manager, Statler Hotel, Los Angeles, Calif.

POSTGRADUATE COURSE IN RADIOLOGY AND RADIOISOTOPES

A postgraduate course in radiology and radioactive isotopes will be presented Feb. 9–11, 1959, at the University of Kansas Medical Center, Kansas City, Kans. On the program are: Jack Ball, Ph.D., of Picker X-ray Co.; Eugene F. Van Epps, M.D., Iowa University Medical School; Melvin M. Figley, M.D., University of Washington Medical School; Colin B. Holman, M.D., Mayo Clinic; Charles Martin, M.D., Dallas, Texas; Edith H. Quimby, Sc.D., Columbia University; John Reeves, M.D., University of Florida Medical School; Don C. Weir, M.D., St. Louis, Mo.

Information relative to the course may be obtained by addressing G. M. Tice, M.D., University of Kansas Medical Center, Kansas City, Kansas.

AMERICAN SOCIETY OF X-RAY TECHNICIANS

The American Society of X-Ray Technicians will hold its Thirty-first Annual Convention at the Shirley Savoy Hotel, Denver, Colo., July 4–9, 1959. For further details address Barbara Riley Hunt, R.T., 1686 S. Bryant, Denver 9, Colo.

AMERICAN CANCER SOCIETY SEMINAR

The Arizona Division of the American Cancer Society is holding its Seventh Annual Cancer Seminar at Paradise Inn, Phoenix, Ariz., Jan. 22–24, 1959. An excellent program has been arranged and it is hoped that physicians from a wide area will be in attendance. Further information is available from Edward H. Bregman, M.D., Chairman, Cancer Seminar Committee, 543 East McDowell Road, Phoenix, Ariz.

In Memoriam

CHESTER A. STAYTON, M.D.

Dr. Chester A. Stayton of Indianapolis, for over thirty years a member of the Radiological Society of North America, died on Oct. 8, 1958. Dr. Stayton was born in Centerton, Ind., in 1889. He received his Bachelor of Arts degree from Indiana University

in 1913, was graduated from the Medical School in 1915, and served his internship in Indianapolis City Hospital, later known as Indianapolis General Hospital. He spent two years in the Medical Corps of the Army in World War I, after which he joined the U. S. Public Health Service, with which he was associated until 1925.

Dr. Stayton was a staff member of St. Francis, Methodist and Community Hospitals, and Witham Memorial Hospital (Lebanon), and was Assistant Professor of Radiology in Indiana University School of Medicine. He was especially interested in cancer and was Director of Region Four of the American Cancer Society. He was a diplomate of the American Board of Radiology, a fellow of the American College of Radiology, a member of the American Radium Society, and a past president of the Indiana Roentgen Society.

Surviving Dr. Stayton are his wife, Marion, a son, Dr. Chester A. Stayton. Jr., also a radiologist, and two daughters, Mrs. James C. Katterjohn and Mrs. John C. Dittrich.

RICHARD CARLETON CURTIS, M.D.

Dr. Richard Carleton Curtis of Bonham, Texas, died on May 28, 1959. Dr. Curtis was born in Georgia in 1890. He attended Georgia Military Academy at College Park, was graduated in pharmacy from the Southern College of Pharmacy, Atlanta, in 1908 and received his degree in medicine from Atlanta Medical College (Emory University) in 1915. Following his internship at Atlanta Clinical Laboratory he became pathologist at King's Daughters Hospital, Temple, Texas. He served in France and Germany during the First World War and returned to Texas in 1919 as clinical pathologist and roentgenologist in Corsicana, where he remained until 1939. He then returned to King's Daughters Hospital and Clinic in Temple as director of the x-ray department. From 1951 until his death he was chief of the radiological service at the Veterans Administration Hospital in Bonham.

Dr. Curtis had been a member of the Radiological Society of North America since 1930. He was a diplomate of the American Board of Radiology, a fellow of the American College of Radiology, and a past-president of the Texas Radiological Society. He is survived by his wife, the former Madie E. Thompson, and by a son and a daughter.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RADIOLOGY FOR MEDICAL STUDENTS. By FRED JENNER HODGES, M.D., Professor and Chairman, Department of Radiology, University of Michigan, ISADORE LAMPE, M.D., Professor, Department of Radiology, University of Michigan, AND JOHN FLOYD HOLT, M.D., Professor, Department of Radiology, University of Michigan. A volume of 450 pages, with 107 plates. Published by the Year Book Publishers, Inc., Chicago, Ill., 3d ed., 1958. Price $8.50.

THE LOVE OF A PHYSICIAN: GEORGE E. PFAHLER, M.D., PIONEER RADIOLOGIST. By MURIEL B. PFAHLER. A volume of 274 pages, with 4 figures. Published by Dorrance & Company, Philadelphia, Penna., 1958. Price $3.75.

EXPERIMENTAL STUDIES ON RADIOACTIVE ZINC IN THE MALE REPRODUCTIVE ORGANS OF THE RAT. By BENGT WETTERDAL. From the Isotope Laboratory, Department of Obstetrics and Gynecology, Sabbatsberg Sjukhus, Karolinska Institutet, Stockholm, Sweden. Acta radiologica suppl. 156. A monograph of 84 pages, with 37 figures and 4 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1958. Price Sw. Kr. 30.—

RADIATION DOSES TO THE GONADS OF PATIENTS IN SWEDISH ROENTGEN DIAGNOSTICS: STUDIES ON MAGNITUDE AND VARIATION OF THE GONAD DOSES TOGETHER WITH DOSE REDUCING MEASURES. By LARS-ERIC LARSSON. From the Institute of Radiophysics, King Gustaf V Jubilee Clinic, Karolinska Sjukhuset, Stockholm, Sweden. Acta radiologica Suppl. 157. A monograph of 128 pages, with 32 figures and 58 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1958. Price Sw. Kr. 30.—

ANGIOCARDIOGRAPHIC OBSERVATIONS IN MITRAL DISEASE WITH SPECIAL REFERENCE TO VOLUME VARIATIONS IN THE LEFT ATRIUM. By HAKAN ARVIDSSON. From Roentgen Department I and the Heart Clinic, Södersjukhuset, Stockholm, Sweden. Acta radiologica Suppl. 158. A monograph of 124 pages, with 39 figures and 3 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1958. Price Sw. Kr. 30.—

PERCUTANEOUS SELECTIVE ANGIOGRAPHY OF THE COELIAC ARTERY. By PER ÖDMAN. From the Central Department of Radiologic Diagnosis, Karolinska Sjukhuset, Stockholm, and Department I of Radiologic Diagnosis, Södersjukhuset, Stockholm, Sweden. Acta radiologica Suppl. 159. A monograph of 168 pages, with 49 figures and 14 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1958. Price Sw. Kr. 35.—

TREATMENT OF CANCER AND ALLIED DISEASES. VOLUME I: PRINCIPLES OF TREATMENT. BY FIFTY-FIVE AUTHORS. Edited by GEORGE T. PACK, M.D., F.A.C.S., Attending Surgeon, Memorial

Center for Cancer and Allied Diseases; Associate Professor of Clinical Surgery, Cornell University Medical College; Surgeon, Pack Medical Group, New York; and IRVING M. ARIEL, M.D., F.A.C.S., Associate Clinical Professor of Surgery and Associate Attending Surgeon, New York Medical College, Flower and Fifth Avenue Hospitals; Surgeon, Pack Medical Group, New York. A volume of 646 pages, with 505 figures. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York, 2d. ed., 1958. Price $22.50.

SYMPOSIUM ON INFORMATION THEORY IN BIOLOGY, GATLINBURG, TENNESSEE, OCTOBER 29–31, 1956. Edited by HUBERT P. YOCKEY, Oak Ridge National Laboratory. With the assistance of Robert L. Platzman, Purdue University, and Henry Quastler, Brookhaven National Laboratory. A volume of 418 pages, with numerous figures and tables. Published by Symposium Publications Division, Pergamon Press, New York 22, 1958. Price $12.00.

ELEMENTS OF BIOPHYSICS. By JAMES E. RANDALL, B.S.E.E., M.S., PH.D., Associate Professor of Physiology and Biophysics, Department of Physiology and Pharmacology, University of Missouri Medical Center. A volume of 334 pages, with figures and tables. Published by the Year Book Publishers, Inc, Chicago, Illinois, 1958. Price $8.00.

SYMPOSIUM ON CANCER OF THE LIVER AMONG AFRICAN NEGROES, HELD BY THE INTERNATIONAL UNION AGAINST CANCER IN KAMPALA, UGANDA, AUGUST 1956. Chairman: Dr. Harold L. Stewart. Editor: Dr. Johannes Clemmesen, Scientific Secretary to the Symposium. Acta Unio Internationalis Contra Cancrum, Vol. XIII, Nos. 4–5, 1957. A volume of 368 pages, with figures and tables. Published by Union Internationale contre le Cancer, 61, Voer des Capucins, Louvain, Belgium, 1957. Price $6.00; by subscription, $25.00 a year.

SYMPOSIUM IN LÉOPOLDVILLE, SEPTEMBER 1956. Acta Unio Internationalis Contra Cancrum, Vol. XIII, No. 6. A volume of 102 pages, with figures and tables. Published by Union Internationale contre le cancer, 61, Voer des Capucins, Louvain, Belgium, 1957. Price, by subscription, $25.00 a year.

MENTAL HEALTH ASPECTS OF THE PEACEFUL USES OF ATOMIC ENERGY: REPORT OF A STUDY GROUP. World Health Organization Technical Report Series No. 151. A pamphlet of 54 pages. Published by World Health Organization, Palais des Nations, Geneva, Switzerland, 1958. Distributed in the United States by Columbia University Press, International Documents Service, New York 27. Price 60 cents; 3/6; Sw. fr. 2.—

TWELFTH INDIAN CONGRESS OF RADIOLOGY, KANPUR, 1958: PRESIDENTIAL ADDRESS. By CAPT. P. B. MUKERJI, B.Sc., M.B. (Cal.), F.R.C.S. (Edin.), F.F.R. (Lond.), D.M.R.E. (Camb.), F.I.C.S., F.S.M.F. A monograph of 32 pages. Published by the author, P-5, Gariahat Road, Calcutta 29, India.

SONDERAUSSCHUSS RADIOAKTIVITÄT BUNDESREPUBLIK DEUTSCHLAND. ERSTER BERICHT, JANUAR 1958. A monograph of 68 pages, with 5 figures and 14 tables. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in U. S. A. and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 4.50 ($1.10).

Book Reviews

RADIATION PROTECTION. By CARL B. BRAESTRUP, Director, Physics Laboratory, Francis Delafield Hospital, Associate, Department of Radiology, Columbia University, New York, N. Y., Member, Executive Committee, National Committee on Radiation Protection and Measurements, and HAROLD O. WYCKOFF, Chief, Radiation Physics Laboratory, National Bureau of Standards, Washington, D. C., Secretary, International Commission on Radiological Units and Measurements. A volume of 362 pages, with figures and tables. Published by Charles C Thomas, Springfield, Ill., 1958. Price $10.50.

The first third of this book supplies the background for the discussion of radiation protection problems which follows. It gives a brief description of the production and attenuation of radiation, and of its measurement. A section on radiation biology contributed by Titus C. Evans and S. Allan Lough includes a discussion of radiosensitivity and factors affecting dose response.

The subsequent chapters deal with the problems to be met in designing protection and give data for solving them. First, all of the factors which must be taken into account in calculations are given, with a general discussion of protection methods and materials. Next, specific problems are discussed in detail. These include medical applications—fluoroscopy, radiography, photofluorography, and therapy—and industrial and other nonmedical installations. Megavolt installations and sealed radioactive sources are discussed in detail. A chapter by Lough on nonsealed sources begins with laboratory design and goes on to medical and industrial uses of isotopes. Problems associated with atmospheric contamination are discussed by Merrill Eisenbud. The last chapter deals with hazard control and includes methods of personnel monitoring, supervision, and radiation surveys.

The discussions are simple, clear, and practical, and numerous graphs and charts give information

which is invaluable to anyone planning irradiation facilities. Radiological physicists will be interested in the sample protection surveys included. This book supplies a long-felt need of those concerned with radiation protection.

RADIOLOGICAL PHYSICS. By M. E. J. YOUNG, M.Sc., formerly Lecturer in Physics, Royal Free Hospital School of Medicine (University of London). A volume of 366 pages, with 184 figures. Published by Academic Press, Inc., New York 3, N. Y., 1957. Price $7.50.

After an extremely brief account of atomic theory, emission of radiation by atoms, and wave mechanics, the author of this text on radiological physics goes into considerable detail in the chapters on electronics and equipment for the production of radiation, including here the accelerators, the betatron, and the synchrotron. Less than half the book is devoted to interaction of radiation with matter, measurement of radiation, chemical and biological effects, and diagnostic and therapeutic uses of radiation. Co^{60} teletherapy receives only brief mention, but radium therapy—surface, interstitial, and intracavitary—is covered in detail.

Although the author states that the book is meant for students and physicists "just starting hospital work," there is little fundamental theory and some use of calculus. The work has some supplemental value for the sake of another approach to the subject.

RADIOGRAPHY OF THE LARGE INTESTINE BASED ON DYNAMIC OBSERVATION. By FUJIO MATSUNAGA, Professor of Internal Medicine, School of Medicine, Hirosaki University. In Japanese and English. A volume of 270 pages, with 508 roentgenograms and 51 photographs, 35 of which are in color. Published by Igaku Shoin, Ltd., 6–20 Hongo Bunkyo-Ku, Tokyo, Japan, 1958. Price 5,000 yen.

The unique feature of this book on radiography of the large intestine is that it is written in both Japanese and English, though the text in one language does not exactly duplicate that in the other. Case histories and clinical observations are given in somewhat greater detail in Japanese and are summarized in English, but this is offset by the fuller English legends.

After a brief introductory section, the book becomes essentially an atlas of typical roentgenograms, which speak equally clearly to both nationalities. Well selected illustrations of good quality show nearly all of the important lesions of the large bowel. A number of color plates, including photographs of gross specimens and views of the colonic mucosa, the latter taken with the "sigmoidocamera" devised by the author, add interest and value to the work.

An English index is provided.

LA ROENTGENTHÉRAPIE DES AFFECTIONS RHUMATISMALES. By PIERRE PIZON. A volume of 276 pages, with 60 figures and 39 tables. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris, 6e, France, 1957. Price, paper bound, 2,800 francs.

The author's concept of *affections rhumatismales* includes a considerable number of painful syndromes not necessarily associated with true rheumatism. Among the conditions which he discusses with reference to roentgen therapy are cervicobrachial neuralgia, scapulohumeral periarthritis, sciatic neuralgia, lumbar pain, degenerative arthritis of the hip, chronic degenerative and chronic progressive inflammatory rheumatism. Several chapters are devoted to physics, technic, and the biology of irradiation.

This work is the result of the careful observation of more than 1,000 patients, treated by the author, and an extensive review of the literature. A complete review of the clinical symptoms and findings for each disease along with the important forms of accepted treatment is presented. All results are tabulated.

The book presents a complete analysis of the possibilities of irradiation in the treatment of a large number of painful diseases of the joints. The study is probably too extensive and the indications for radiation too generous in dealing with benign conditions.

DER LUNGENBOECK IM RÖNTGENBILD. By PROF. DR. KARL WURM, Chefarzt privater Kuranstalten in Höchenschwand i. Schw., a. o. Professor für inn. Med. der Universität Freiburg/Brsg., PROF. DR. REINDELL, Oberarzt der Med. Universitätsklinik, Leiter der Röntgen-Radium-Abteilung Freiburg/Brsg., and PROF. DR. DR. H. C. L. HEILMEYER, Direktor der Med. Universitätsklinik Freiburg/Brsg. A volume of 220 pages, with 209 roentgenograms, 5 charts and diagrams, and 13 tables. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 78.—($18.55).

This monograph is the result of the collaboration of two internists and one radiologist who made a careful study of 400 patients with Boeck's sarcoid with respect to the clinical aspects and, more particularly, the radiologic pattern of the lungs and mediastinum.

The book consists of ten chapters, of which the eighth and ninth are outstanding. After a short introduction, the clinical features of the disease are discussed, with an attempt at correlation of the three clinical stages with the roentgen picture. Subsequently, the relationship between the localization of the disease process and regional lymph-node enlargement, the influence of cortisone therapy, and the

effect of pregnancy are considered. In the eighth chapter, consisting of 136 pages, 63 case histories are given, illustrated by excellent chest roentgenograms, tomograms, and contact films. The ninth chapter is devoted to differential diagnosis, based on the roentgen studies. The final chapter discusses briefly prognosis and therapy.

The illustrations, drawings, and typography are excellent and the monograph is recommended to clinicians and radiologists interested in this subject.

EINFÜHRUNG IN DIE MESSTECHNIK DER KERNSTRAHLUNG UND DIE ANWENDUNG DER RADIOISOTOPE. By PROF. DR. HEINRICH FASSBENDER, Professor (em.) der Technischen Universität Berlin, Erlangen/Berlin. A volume of 224 pages, with 142 figures and 15 tables. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 37.50 ($8.85).

This book gives a clear, concise picture of the use of isotopes and the measuring technics of radiation. A brief introduction to nuclear physics is followed by a discussion on radiation-detecting devices such as GM tubes, scintillation counters, ionization chambers, and autoradiography. The details of the electronic instruments which are used in connection with the detectors concern both principle and use. The ensuing section of the book deals with the medical application of these instruments and detectors. Tracer methods, diagnostic isotope procedures, and isotope therapy are included in this discussion.

The author does not limit himself to the medical aspects of his subject but goes further into the matter of x-ray spectrum analyses and the uses and technics of isotopes in chemistry, agriculture, archeology, and other fields. The book concludes with a biological outlook on protection from radiation and a description of the instruments used for protection measurements.

This work is especially informative for anyone not familiar with the fundamentals of the field. Excellent pictures and diagrams are coupled with a sequence of material which is beneficial to the reader. The author has the enviable ability to fill his sentences with many facts, still maintaining a pleasing style of writing.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Heart and Blood Vessels

The Breast

The Digestive System

Hernia

The Musculoskeletal System

Gynecology and Obstetrics

The Genitourinary System

Miscellaneous

Technic

RADIOTHERAPY

RADIOISOTOPES

RADIATION EFFECTS—PROTECTION

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Arteriovenous Anomalies of the Brain. A Review and Presentation of 37 Cases. Frank M. Anderson and Marvin A. Korbin. Neurology **8:** 89–101, February 1958. (University of Southern California School of Medicine, Los Angeles, Calif.)

This paper is concerned with the so-called "congenital arteriovenous anomaly" of the brain consisting of a coiled mass of arteries and veins partially separated by thin strips of sclerotic nervous tissue, and lying in a bed formed by displacement rather than invasion of the surrounding cerebrum or cerebellum. Thirty-seven cases are reviewed.

Arteriovenous anomalies range from microscopic malformations (known as "cryptic" arteriovenous hamartomos) to huge masses. They may be multiple. Hemorrhage was the first symptom in 20 of the authors' patients (54 per cent). Convulsions were the initial manifestation in 9 cases (24 per cent), chronic headache in 5, pain in the face in 2, and prominent facial veins in 1. About 90 per cent of the anomalies are discovered before the age of forty. The "cryptic" variety is reported most commonly in children and young adults, suggesting that this type tends to rupture early in life. Hemorrhage may destroy the anomaly and the etiology of the intracerebral clot found at autopsy may be overlooked if the wall of the hemorrhagic cavity is not examined microscopically. An unusual malformation is that comprising direct arteriovenous shunt between the anterior, middle, or posterior cerebral artery and the vein of Galen. Distention of the latter compresses the aqueduct and produces hydrocephalus.

A bruit was noted in 6 of 20 patients (30 per cent) in whom auscultation was recorded. Electroencephalography indicated the site of the lesion in 4 of 15 patients tested.

Changes were demonstrable on plain skull films in 22 per cent of the authors' patients. Curvilinear calcifications were observed in a small portion of the lesion in 4 patients, erosion of bone adjacent to the anomaly in 2, a circular opening for passage of a large emissary vein in 1, and marked enlargement of meningeal grooves in another. The most important diagnostic procedure is cerebral arteriography, preferably with a serial device. If the patient's condition permits, arteriography should be performed within a day or two after hemorrhage has occurred. It is important to determine the principal arterial supply to the anomaly and whether this is from one or both carotids or from the vertebral as well as the carotid circulations. The major supply was from the middle cerebral artery in 23 cases in the present series, from the anterior and posterior cerebral in 17 and 6, respectively, and from external carotid branches in 1.

The location of the anomaly in 12 cases was parietal, in 7 cases frontal or frontoparietal, in 7 temporal or temporo-occipital, in 3 occipital, and in 2 midline (anterior cerebral artery-vein of Galen). In no instance was the cerebellum involved. The size of the anomaly, venous drainage, and precise relation of abnormal vessels to important areas of the brain should be noted. Arteries other than those supplying the anomaly are often poorly filled during arteriography. Displacement of adjacent vessels and a "blank" area near the lesion suggest the presence of cerebral hematoma. Differentiation between a well demarcated arteriovenous anomaly and a highly vascular tumor is sometimes difficult.

Complete excision of the lesion is the ideal treatment whenever technically feasible. The patient's status and the accessibility of the lesion must be evaluated before surgery is performed, since prognosis without operation is favorable in many instances.

Nine roentgenograms; 3 photographs; 2 photomicrographs.

SAMUEL B. HAVESON, M.D.
University of California, S. F.

The Megalencephalic Phase of Infantile Amaurotic Familial Idiocy. Cephalometric and Pneumoencephalographic Studies. Stanley M. Aronson, Alexander Lewitan, Abraham M. Rabiner, Nathan Epstein, and Bruno W. Volk. Arch. Neurol. & Psychiat. **79:** 151–163, February 1958. (B. W. V., Isaac Albert Research Inst., 86 East 49th St., Brooklyn 3, N. Y.)

This report is concerned with serial cephalometric and pneumoencephalographic studies of 15 children with amaurotic familial idiocy, or Tay-Sachs' disease. In many of these patients, the average life span was significantly prolonged, culminating in a suddenly developing and unremittent cranial enlargement, a feature which had not been associated with this illness in the past. Beyond twenty-four months of determined illness, a markedly increased head circumference was noted, and increase of brain mass was visualized radiographically. These findings were confirmed at autopsy.

Morphologic studies clarified the paradox of increased brain weight in the presence of progressive neuronal degeneration by showing the late megalencephaly to be the result of a reactive glial overcompensation and hyperplasia.

Eight roentgenograms; 3 photographs; 3 graphs; 1 table.

JAMES A. BURWELL, M.D.
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Bony Changes in the Skull in Tuberculous Meningitis. Roy M. Acheson. Brit. J. Radiol. **31:** 81–87, February 1958. (Radcliffe Infirmary, Oxford, England)

The skull films of 313 patients with tuberculous meningitis were reviewed in this study. Serial examinations were available in most of the cases.

Radiologic evidence of pressure changes depended upon duration of the disease and the age of the patient. The changes of the cranial vault appeared to have little prognostic significance, but those of the floor of the skull seemed important.

The pituitary fossa was often seen to undergo enlargement, mostly in length, during the course of the disease. This was true in both adult and childhood cases. Erosion of the sella occurred only in association with some complication, such as pituitary adenoma, posterior fossa tuberculoma, etc. In one case sellar erosion developed rapidly in the presence of aqueduct obstruction, with later reorganization after the obstruction was relieved.

Sutural separations and delayed closure of fontanels were common in patients under four years of age. They were less common in older children. Before three years the lambdoid suture was most commonly affected, from four to nine years the coronal and sagittal sutures.

During convalescence, when cerebrospinal fluid pres-

sure decreased, the stretched membrane ossified without any decrease in head size. The bone edges along sutures, fontanels, and burr holes showed eversion. After cure of the meningitis, further growth of the childhood skull sometimes was impeded, possibly because of inability of damaged suture lines to produce further ossification.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

The Roentgen Appearances of the Carotid Sulcus of the Sphenoid Bone. E. P. Engels. Acta radiol. **49:** 113–116, February 1958. (Montreal Neurological Institute, Montreal, Canada)

On each lateral edge of the superior surface of the basisphenoid there is a broad groove termed the "carotid sulcus." It forms a sigmoid curve above the attachment of each greater wing of the sphenoid and on lateral films of the skull its margins may be visible against the background of the pneumatized sphenoid body. It harbors the cavernous sinus and varying portions of the carotid artery.

The various appearances of the margins of the sulcus as observed in 100 consecutive normal skull examinations are illustrated. No specific patterns could be correlated with any pathologic entities. In 64 per cent of the cases, all or part of the sulci could be observed. It seemed that whether or not the sulcus was visible depended largely upon the amount of pneumatization of the sphenoid bone.

Two figures.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Parotid Sialography. Roentgenologico-Surgical Correlation in a Series of 70 Cases. Robert A. J. Einstein and Samuel L. Perzik. California Med. **88:** 98–102, February 1958. (300 South Beverly Drive, Beverly Hills, Calif.)

Accurate preoperative localization of a parotid mass is important, since the present concept of surgery calls for resection of the entire gland or of one of its lobes, and this is often done without the surgeon ever visualizing the lesion. The authors describe their technic of sialography and report a study of 70 cases.

Abnormal findings were grouped as intrinsic mass lesions, extrinsic masses, and ductal abnormalities. All masses were localized as accurately as possible on the basis of the films. Of 58 patients who came to surgery, the roentgen diagnosis was correct in 50; 35 of these had neoplasms. In 7 cases the diagnosis of neoplasm was correct but the mass was incorrectly located. In 1 patient with a small lymph node embedded in the gland, the films were interpreted as normal. Correlation of the clinical diagnosis with the surgical findings showed a correct diagnosis and localization in 47 of the 58 patients.

The authors feel that sialography does not permit an accurate differential diagnosis of the various parotid neoplasms, but that it has distinct value in distinguishing between an inflammatory and a neoplastic process, and in localizing a mass when it is present.

Ten roentgenograms.

LAWRENCE A. POST, M.D.
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THE CHEST

The Chest Roentgenogram and Chest Roentgenographic Surveys Related to X-ray Radiation Effects and Protection from Radiation Exposure. Executive Committee of the American Trudeau Society. Am. Rev. Tuberc. **77:** 203–208, February 1958.

This report, dealing with radiation exposure, originated in a meeting of the Executive Committee of the American Trudeau Society to formulate policy and give recommendations. Several expert technical advisors were present at the meeting. The committee concluded that radiation serves a necessary purpose and that the benefits of radiography should be weighed against the effects of exposure. When it fills a need, it is warranted but should be used with the best protective devices available. The recommendations are as follows:

1. Chest roentgenographic surveys must be continued for the detection of tuberculosis, cancer, industrial thoracic disease, acute and chronic nontuberculous infections, chest tumors, and cardiovascular abnormalities.

2. Conventional and photofluorographic x-ray units may be used to survey segments of the population expected to show a high yield of thoracic disease. The x-ray machines must be equipped with adequate protective devices including cones, filters, and shielding, as well as exposure controls. These devices should be obtained immediately.

3. Survey of infants, children, young adults, prenatals, and young diabetics should be made by means of tuberculin testing. Chest roentgenography could then be limited to those with positive tuberculin tests.

4. Case finding programs should be reassessed and directed to groups most deserving of chest roentgenographic surveys or tuberculin testing.

5. Instruction and training of personnel should include information concerning protective devices for all types of x-ray units.

6. Health workers and the public should be educated with emphasis on the continuing usefulness and need for early diagnosis and treatment of pulmonary disease. It should be made known to all concerned that effective steps have been taken to minimize direct and scatter radiation exposure.

7. Members of the American Trudeau Society and National Tuberculosis Association might assume an active role in assisting in and promoting the training of personnel skilled in radiation protection. Such a program could develop and play an important part in assuring the confidence of the public that the leadership of these organizations in the field of thoracic disease carries with it the certainty of minimal radiation exposure and the maximal protection whenever chest roentgenographic examinations are used in survey and diagnostic work under their sponsorship.

JOHN H. JUHL, M.D.
University of Wisconsin

Late Results of Bronchography Using Dionosil Oily. W. S. Holden and R. H. Cowdell. Acta radiol. **49:** 105–112, February 1958. (United Oxford Hospitals, Oxford, England)

The purpose of this paper is to record the results of bronchography after five years continuous use of Dionosil Oily. The study included examination of resected lung tissue from patients previously submitted to bronchography. A special study was made of lung tissue from 49 patients with nontuberculous bronchiectasis on whom 74 bronchograms had been performed.

As far as the authors are able to tell, no long term ill effects have occurred in a series of over 2,000 broncho-

grams with Dionosil Oily. Nothing was seen in the resected lung tissue to suggest damage from the medium. Foreign body granulomata were quite rare in the series, and none contained fatty material.

Previous reports of granulomata developing in rats after use of this medium were not substantiated in man, possibly due to the routine recovery by suction of contrast medium after the examination.

Two photomicrographs; 2 diagrams.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Lobar Agenesis of the Lung. Richard H. Adler, Jack W. Herrmann, and Theodore C. Jewett, Jr. Ann. Surg. **147:** 267–272, February 1958. (Children's Medical Center of Buffalo, Buffalo, N. Y.)

Agenesis or congenital absence of a lung is uncommon, but is being recognized with increasing frequency, and must be considered in the differential diagnosis of certain intrathoracic diseases.

The abnormality may be grouped into three categories: (1) agenesis, or complete absence of bronchus and lung; (2) aplasia, rudimentary bronchus without surrounding lung parenchyma; (3) hypoplasia, bronchus with small rudimentary underdeveloped lung mass.

A case of agenesis (aplasia) of the right upper lobe and right middle lobe in a twenty-four month-old female is presented. An associated stenosis of the bronchus intermedius and an aberrant artery were found.

The patient was admitted for severe respiratory infection, and a preliminary chest film was interpreted as showing atelectasis and pneumonic consolidation of the right upper lobe. Foreign-body aspiration was also suspected. The child was not in acute distress and the temperature was normal. Numerous studies, including multiple bronchoscopies and bronchography, were performed. The first bronchograms showed an atretic right upper lobe bronchus and narrowed bronchus intermedius. Unsatisfactory filling prevented visualization of the remaining distal bronchial tree. Bronchography was later repeated, showing that the right upper lobe and middle lobe bronchi ended blindly. The right lower lobe appeared to fill most of the right hemithorax. Although there was a variation in diagnosis offered, lobar agenesis and stenosis of the bronchus intermedius with recurring pneumonitis was considered most likely. This was confirmed by operation, and the right lung was resected. The patient was later asymptomatic.

Two roentgenograms; 1 photograph; 1 drawing.

FRANK T. MORAN, M.D.
Auburn, N. Y.

A Rare Case of Bilateral Cervical Spontaneous Pulmonary Herniation. G. Farinet and I. Stoppa. Radiol. med., Milan **44:** 41–53, January 1958. (In Italian) (Istituto di Radiologia della Università di Torino, Italy)

Following a coughing spell, a 54-year-old female experienced sharp pain under both shoulder blades and suddenly a large swelling appeared at the base of the neck, just above the clavicles. The swelling receded spontaneously, only to recur whenever the patient coughed, blew her nose, or otherwise raised the intrathoracic pressure. An intensive study, including bronchography as well as stratigraphy, demonstrated that the swelling was caused by emphysematous portions of both pulmonary apices, which had forced their way through an "abnormal" opening and penetrated into the easily distended areolar tissue of the supraclavicular fossa.

This is an extremely rare occurrence, the first case having been reported in 1950 by Van Wezel (J.A.M.A. **142:** 804, 1950). The herniation must not be confused with the bulging apices encountered in chronic emphysematous patients, for which no treatment is deemed necessary (as far as the bulge is concerned). Conversely, when true herniation of the lung has been proved, surgical occlusion of the "abnormal opening" is the only logical approach. Moreover, one must not procrastinate, because the tissues can stretch to the point where excessive relaxation may preclude satisfactory repair when the decision to operate has been reached too late.

Fourteen roentgenograms. E. R. N. GRIGG, M.D.
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The Clinical Significance of the Tracheal Bronchus. John H. Harris, Jr. Am. J. Roentgenol. **79:** 228–234, February 1958. (Hospital of the University of Pennsylvania, Philadelphia, Penna.)

A case is presented in which the bronchus to the apical segment of the right lung arose from the trachea. Several cases of tracheal bronchus have been reported. Apparently this anomaly does not occur on the left but always involves the right lung. Pathologic findings are characteristic of those associated with any segmental bronchus, and the condition does not appear to be of any specific clinical significance. The author reviews a number of theories of pulmonary evolution and embryology in reference to the origin of this anomaly.

A topographical nomenclature is suggested, with the terms "tracheal" and "carinal" suggested to designate the abnormal site of origin of the bronchus. The latter term includes origin at the bifurcation or 1.0 cm. above it; "tracheal" denotes origin from the trachea proximal to 1.0 cm. above the carina.

Three roentgenograms; 6 drawings.

CAPT. NEIL E. CROW, M.C.
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Laminagraphic Appearance of Bronchiectasis. Edward Newell Burke. Am. J. Roentgenol. **79:** 251–257, February 1958. (333 Winthrop St., Medford 55, Mass.)

Bronchography is the logical method of examination in a patient suspected of having bronchiectasis. Laminagraphy is not a substitute for this procedure, but in some instances it will demonstrate the disease more clearly and bring out additional features. In laminagraphic studies for visualization of a hilar mass or tuberculous cavity, or in routine examination of a patient with hemoptysis, bronchiectatic changes are often discovered.

The laminagraphic signs of bronchiectasis consist in dilated, irregular, thick-walled bronchi, which may be seen in various views. Whenever the conditions necessary for the development of bronchiectasis are present, as they are in chronic inflammation, bronchostenosis, atelectasis, fibrosis, or congenital bronchial malformations, bronchiectasis should be sought.

The author reports four cases in which the diagnosis of bronchiectasis was facilitated by the use of laminagraphy: (1) chronic basilar pulmonary infection, (2) left lower lobe atelectasis, (3) tuberculous infiltration in the right apex, (4) unresolved pneumonia associated

with a poorly delineated cyst in a 10-year-old girl. In each case bronchography or operation confirmed the presence of bronchiectasis.

Thirteen roentgenograms.

ROBERT S. ORMOND, M.D.
Dearborn, Mich.

The Solitary Pulmonary Nodule. A Review of 236 Consecutive Cases, 1944 to 1956. Richard R. Taylor, Laurence N. Rivkin, and John M. Salyer. Ann. Surg. **147:** 197–202, February 1958. (Fitzsimons Army Hospital, Denver 8, Colo.)

An analysis of 236 cases of solitary pulmonary lesions seen over a twelve-year period is presented. The age of the patients ranged from seventeen to seventy-four years, and the size of the pulmonary lesions from 1 to 6 cm. as seen on the roentgenogram. A total of 183 lesions proved to be granulomas resulting from tuberculosis or fungous infection, or of undetermined etiology. Twenty-three patients had malignant lesions, 17 of which were bronchogenic carcinoma; 10 had benign tumors.

The x-ray appearance of the lesion was of some diagnostic value. Most granulomas had smooth borders, whereas 19 of 36 lesions with irregularity or fuzziness of the border were malignant tumors. Ninety-four per cent of all bronchogenic carcinomas appearing as solitary nodules had definite irregularity or fuzziness of the borders.

Calcification was noted within the solitary nodule in 58 cases, consisting of small flecks or small central calcific densities. Although 56 of this group were subsequently proved to be granulomas, 2 were definite tumors.

In evaluating the solitary pulmonary nodule, age, roentgen characteristics, presence or absence of calcium, and specific skin tests must be carefully considered.

Three tables.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Intrathoracic Meningocele. Paul Teng and Peter Eastman. Neurology **8:** 153–156, February 1958. (Kaiser Foundation Hospital, Los Angeles, Calif.)

A case of intrathoracic meningocele in an asymptomatic 34-year-old man is reported, the twenty-fourth such lesion recorded in the literature. The meningocele was discovered on a routine chest film, presenting as a spherical mass (diameter 2 1/2 inches) in the superior mediastinum, located posteriorly on the right, adjacent to the vertebral column. The spine showed absence of the pedicles on the right from C-7 to T-3, narrowing of the T-4 pedicle and scalloping of the right margin of the body of T-2. Thoracotomy confirmed these findings and revealed the extrapleural location of the meningocele and its communication with the subarachnoid space. The spinal cord was normal, but the dentate ligament on the exposed side of the cord was absent. The patient also had a neurofibroma of the scalp, but no other stigmata of neurofibromatosis were found.

Of 24 reported cases (including the authors'), neurofibromatosis was described in 15. The meningocele was an accidental finding in 9 asymptomatic patients. Symptoms and findings related to spinal cord deficit or pressure on nearby structures were present in 12 cases. Roentgenograms revealed bone changes in 19 patients. These findings included erosion of neighboring ribs, vertebral bodies, and/or intervertebral foramina, erosion or absence of pedicles, and scoliosis of the dorsal spine. Myelography was utilized in 5 cases. An accurate diagnosis of intrathoracic meningocele was made in only 2 of 14 instances prior to 1950, whereas 6 of 10 cases were correctly diagnosed from 1951 to 1957. The lesion was removed in 10 cases and no recurrences have been reported.

Intrathoracic meningocele is analogous to meningocele found elsewhere in the body and is probably due to defective development of the dura and bony enclosure. Nerve roots are not involved, and rupture is unlikely because of the protective thoracic cage. It is the authors' opinion that asymptomatic intrathoracic meningoceles need not be removed, but removal is desirable if the lesion is discovered accidentally during exploratory thoracotomy or if pressure symptoms are present.

One roentgenogram; 1 table.

SAMUEL B. HAVESON, M.D.
University of California, S. F.

Cystic Cavities in Pulmonary Tuberculosis Treated with Isoniazid. Vladimir Altmann and Raphael M. Diaz. Am. Rev. Tuberc. **77:** 221–231, February 1958. (Sea View Hospital, Staten Island, N. Y.)

The authors studied 157 surgically resected lung specimens and the lungs of 91 patients on whom autopsy was performed. All of these patients had been treated for pulmonary tuberculosis with isoniazid. Cystic cavities were found to occur in locations usually occupied by tuberculous cavities. The walls were smooth, were made up of fibrous tissue, and were thicker than those usually seen in emphysematous cysts. There were no associated gross emphysematous changes elsewhere. No bronchial elements were present in the wall. Since the lining of these cysts is made up of fibrous tissue without evidence of tuberculous disease, there is no definite way of making certain that they represent healed cavities.

Roentgenographically thin-walled radiolucent defects with smooth outlines are demonstrated, often in an area where a thick-walled cavity appeared earlier. The occurrence of these lesions is more frequent in patients treated with isoniazid than in those treated with streptomycin or before the use of the anti-tuberculous drugs. This, along with the other evidence indicating that these lesions represent "healed" cavities, is only circumstantial, but is reasonably valid. When a patient with such a lesion has positive sputum, it is not possible to ascertain whether the cavity is healed or contains active disease on clinical or roentgenographic study.

One photomicrograph; 2 photographs; 1 table.

JOHN H. JUHL, M.D.
University of Wisconsin

Farmer's Lung—A Form of Pneumoconiosis Due to Organic Dusts. Ralph C. Frank. Am. J. Roentgenol. **79:** 189–215, February 1958. (550 North Dewey Street, Eau Claire, Wisc.)

The author presents 27 cases of farmer's lung with a number of case reports nicely outlining the variations of onset and course. The disease process appears to include two fundamental reactions: (1) an initial pulmonary response to inhalation of organic dust involving a granulomatous reaction with associated interstitial fibrosis; (2) subsequent sensitization to such dust, with progressive pulmonary fibrosis on repeated exposure. The initial attack is characterized by dyspnea, cough,

fever and chills, night sweats, and weight loss. Some permanent pulmonary disability may follow, and severe disability of an increasing nature occurs with repeated exposure, once sensitization has developed. This disability appears to be associated with an interstitial fibrosis and is characterized by dyspnea, diminished vital capacity, cor pulmonale or right heart strain, and secondary polycythemia on occasion.

Characteristic roentgenologic changes in the acute stage consist of fine to coarse granular and nodular mottling scattered diffusely throughout both lung fields, which apparently cannot be easily differentiated from the multiple other diseases giving rise to a "miliary" appearance. These nodulations vary in size and may coalesce if progression occurs. Clearing is gradual and may be ultimately complete, although mild emphysema and fibrotic strands not infrequently remain. With continued exposure to the causative agent, coarsening of the truncal markings may be observed compatible with an active interstitial process leading to fibrosis, pulmonary hypertension, and eventually cor pulmonale. The final stage consists of severe pulmonary fibrosis and emphysema with accompanying right heart strain.

The dusts involved are most often due to moldy hay, grain, or silage, and the heavy fungal spore content of such dust is believed to be largely responsible for the disease. Rarely the syndrome is due to vegetable dusts which are not significantly moldy. The pulmonary reaction to the fungal spores is believed to be attributable to their action as foreign material rather than actual pulmonary infection or mycosis.

In view of the progressive disabling nature of the disease, the author strongly recommends that affected individuals should change their occupation. Preventive measures should be widely advocated in an effort to save the individual farmer from developing this economically disastrous disease.

Sixteen roentgenograms; 3 photomicrographs; 1 table.

CAPT. BYRON G. BROGDON, M.C.
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A Possible Case of Pulmonary Moniliasis. Paul W. Scott. Am. Rev. Tuberc. **77:** 329–337, February 1958. (University Hospitals, Iowa City, Iowa)

This case report concerns a woman who was first seen with chronic cavitary disease with moderate inflammatory consolidation in the right lung. Local disease developed in the left midlung field a few weeks later. The roentgenographic densities were patchy, poorly defined, and fluffy in outline, and tended to change from week to week. Physical findings and history were of little help in determining the etiology, but the patient did not appear as ill as the far advanced roentgen findings would indicate. She had an allergic history and Loeffler's syndrome was suggested. *Candida albicans* was cultured repeatedly from bronchoscopic aspirations, sputum, gastric washings, and stools. No other etiologic agent was found. There was a positive agglutination for *Candida albicans* at a high titer, while other agglutination, complement fixation, and skin tests were negative. Penicillin and streptomycin had no effect on the disease, but with potassium iodide symptoms cleared completely within one week. Roentgen evidence of pulmonary disease also disappeared rapidly, and only minimal fibrous residua were noted two weeks later. After three years the patient was still healthy and her chest film was unchanged. The agglutination titer for *Candida albicans* had decreased sixteenfold in the three-year period of observation.

Six roentgenograms; 1 chart.

JOHN H. JUHL, M.D.
University of Wisconsin

Roentgen Manifestations of Torulosis (Cryptococcosis). John N. Wolfe and George Jacobson. Am. J. Roentgenol. **79:** 216–227, February 1958. (G. J., 1200 North State Street, Los Angeles 33, Calif.)

Torula histolytica (*Cryptococcus neoformans*) is a fungus of world-wide distribution. Although usually saprophytic, it is occasionally pathogenic. There is no characteristic clinical feature of disease due to this cause, since multiple organ systems are involved, and the diagnosis can be made only by recovery of the organism. The patients appear to fall into two general groups: (1) those in whom symptoms are sudden in onset and the course rapid, with death ensuing in a few weeks; (2) those in whom the disease has a less dramatic onset and who may live for a considerable number of years. In the first group, meningitis is always present, whereas in the second, involvement of the central nervous system may occur late, or not at all.

The prognosis is very grave. Cures, for the most part, have been limited to those cases in which complete surgical excision has been possible. Death is usually due to meningitis or brain abscess.

The authors report 21 cases in 11 of which there were roentgen-demonstrable lesions. Nine patients had pulmonary lesions which were nonspecific in appearance, ranging from segmental infiltrations to discrete mass lesions indistinguishable from neoplasm, primary or metastatic. Both cavitation and mediastinal lymphadenopathy may be present. Three patients had osseous lesions, consisting of a limited area of bone destruction with a slight periosteal reaction. Ten cases—6 involving the central nervous system and 4 generalized—showed no positive roentgen findings.

Fourteen roentgenograms; 4 tables.

CAPT. NEIL E. CROW, M.C.
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Roentgen Diagnosis of Pulmonary Emphysema, Comparison with Spirometric Findings and Blood Gas Analysis. W. Frik, R. Hesse, and R. Zeilhofer. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 125–133, February 1958. (In German) (Med. Universitätsklinik, Erlangen, Germany)

In pulmonary emphysema the following roentgen signs can be observed: (1) increased radiolucency of the lungs, especially the lower lung fields, without change during respiratory phases; (2) barrel-shaped thorax, occasionally with slight retraction above the bases; (3) widening of the intercostal spaces with a horizontal position of the ribs; (4) low diaphragm with impaired mobility and flattening of the domes; (5) an increased costophrenic angle.

These signs are not absolutely dependable but are only suggestive of emphysema, except in a far advanced stage. Observations have been made in a group of 100 cases and evaluated with the aid of an equal number of healthy chests. The most dependable findings proved to be diminished height of the diaphragm with impaired respiratory excursion, an increased costophrenic angle, and localized retraction of the thorax, bilaterally.

In view of the uncertainties of roentgen findings, all cases were subjected to spirometric tests, and the follow-

ing conclusions are reached: In severe cases with more than 50 per cent of residual volume, roentgen findings are usually reliable; in less severe cases the roentgen changes are not as dependable as the spirometric findings. The diagnosis of localized emphysema can be ascertained only roentgenologically. Direct comparisons with blood gas findings are not yet available. It has been shown, however, that in severe cases, with more than 50 per cent residual volume, an excess of carbon dioxide in the blood can be expected.

Three tables; 1 drawing. ERNEST KRAFT, M.D.
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Gross Anatomico-Spatial Changes Occurring in Lobar Collapse. A Demonstration by Means of Three-Dimensional Plastic Models. George R. Krause and Mortimer Lubert. Am. J. Roentgenol. **79:** 258–268, February 1958. (Mount Sinai Hospital, Cleveland 6, Ohio)

In an earlier article (Radiology **56:** 165, 1951) the authors explained the mechanism of collapse in the various lobes of the lung, using line diagrams to illustrate the direction and mode of shift of a collapsing lobe. An attempt was also made to illustrate diagrammatically the change in shape of the collapsing lobe from a three-dimensional pyramidal structure toward a flat, almost two-dimensional triangle. This, however, was not altogether successful, apparently because the diagrams lacked a three-dimensional effect. To overcome this difficulty the authors have now constructed models of transparent and translucent plastic material which can be viewed from different angles and compared with the roentgenograms. For normal or overexpanded lobes transparent Plexiglas was used; for the collapsed lobe a white translucent Plexiglas. From the front or side one sees the white collapsed lobe through the transparent normal lobe. In the same manner, the roentgen ray penetrates the normal lobe but the collapsed lobe casts a white shadow on the film.

Drawings of the models are reproduced, with accompanying postero-anterior and lateral roentgenograms depicting various degrees of collapse of the left upper, right upper, and left lower lobes.

Twenty roentgenograms; 9 drawings.
ROBERT S. ORMOND, M.D.
Dearborn, Mich.

Roentgenologic Contrast Study of the Superior Vena Cava and of the Innominate Veins in Mediastinal and Paramediastinal Tumors. A. Banfi, A. M. Pagnoni, and L. Rigat. Radiol. med., Milan **43:** 945–988, October 1957. (In Italian) (Istituto di Radiologia della Università di Milano, Italy)

Upper mediastinal phlebography is performed by injecting 30 to 50 c.c. of 70 per cent organic iodinated contrast medium into the vena basilica (or other vein around the elbow) at the rate of about 10 c.c. per second. At the end of the injection, five roentgenograms of the chest are exposed at one-second intervals. In the presence of mediastinal tumors, the superior vena cava and the innominate trunks may reveal *displacements* (either from extrinsic pressure or by alteration of intrathoracic pressure due to atelectasis or pleural effusion), *deformities* (changes in size and shape, caused by compression or infiltration), and/or *obstructions* (with development of collateral circulation, the location of which is indicative of the site of obstruction).

Twenty-two cases are presented, including 3 of substernal thyroid (2 proved by surgery, 1 irradiated), a malignant thymoma and a thymosarcoma (both explored), 4 cases of lymphoma (all biopsied and irradiated), 4 cases of bronchial carcinoma (in 1, autopsy showed findings reminiscent of Pancoast's tumor while the other 3 had bronchoscopic confirmation), 3 cases of metastatic cancer (1 proved at operation and 2 by lymph node biopsies), 6 cases of pathologic changes in the mediastinal venogram not elucidated.

To the findings elicited through conventional roentgenographic technics, phlebography may add significant information concerning the site, extension, and origin of mediastinal and paramediastinal tumors and is of considerable value in the estimation of results of roentgen therapy. At times it is the only way (short of surgery) to study the right mediastinal border, when the latter is obscured by opacification of the lung field; under such circumstances it may demonstrate the existence of an unsuspected neoplasm. It goes without saying that superior mediastinal phlebography must, nevertheless, be considered as only one procedure within a battery of clinical, laboratory, and other tests, which ought to be correlated in order to furnish a complete picture.

Thirty roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Cyst of the Thymus. Report of a Case Presenting as Idiopathic Cardiomegaly. Norman Coulshed, E. Wyn Jones, and Leslie J. Temple. Brit J. Radiol. **31:** 95–99, February 1958. (Sefton General Hospital, Liverpool, England)

This article includes a good discussion of the differential diagnosis of tumors of the mediastinum, and stresses particularly the radiographic features of simple thymic cyst. A detailed case report is presented, in which differentiation from cardiac enlargement was a major problem.

Fluoroscopy with the patient lying in the left anterior oblique position revealed a lobulation, evidently separate from the heart but intimately related to the right and anterior surfaces. There was loss of normal pulsation along the right side of the heart shadow, but normal pulsation on the left. During cardiac catheterization the catheter could not be maneuvered very close to the apparent right heart border. On the strength of these findings a diagnosis of extracardiac neoplasm was made, and later was confirmed at surgery.

Pathologically the cyst was pedunculated and multilocular, containing colloid material. The pedicle arose from seemingly normal thymic tissue.

Five roentgenograms; 1 photomicrograph; 1 photograph; 1 table. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

THE HEART AND BLOOD VESSELS

Method of Radiologic Diagnosis of Congenital Heart Disease in Children. Richard G. Lester, Eugene Gedgaudas, and Leo G. Rigler. J.A.M.A. **166:** 439–443, Feb. 1, 1958. (R. G. L., 412 S. E. Union St., Minneapolis 14, Minn.)

Analysis of fluoroscopic and radiographic findings and their systematic application will provide a means of objective classification of patients with congenital heart disease. In this method of analysis the basic criterion is the *degree of pulmonary arterial vascularity.*

Accordingly, all patients are divided into three classes. The class characterized by increased pulmonary vascularity is the largest and most important, comprising almost 50 per cent of those with congenital heart lesions. It includes interventricular and interatrial septal defects, patent ductus arteriosus, and transposition of the great vessels, as by far the most important types. In the second class, with decreased pulmonary vascularity, tetralogy of Fallot is the prime consideration. The third and statistically smallest group is that with normal pulmonary vascularity. This includes such important entities as coarctation of the aorta and isolated pulmonic stenosis.

The authors emphasize that by application of criteria gained from conventional radiographic procedures, correlated with the history, physical, and electrocardiographic data, *a working diagnosis* is usually possible. Although a myriad of diagnoses must be considered in most congenital heart cases, it is fortunate that relatively few lesions occur with any appreciable frequency. Additional, more complex diagnostic studies may frequently be necessary for pinpointing of the exact anomaly. Retrograde aortography is the procedure of choice for most extracardiac lesions (*e.g.*, aortic coarctation, patent ductus arteriosus). Cardiac catheterization is usually the most definitive diagnostic procedure for left-to-right shunts (*e.g.*, interventricular and interatrial septal defects). Angiocardiography is frequently the best diagnostic procedure in right-to-left shunts (*e.g.*, tricuspid atresia).

The authors consider in moderate detail the diagnostic criteria for specific entities. Many helpful differential points are given. The paper contains a large amount of helpful factual information in concentrated form and is recommended to those interested in this subject.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Atrial Septal Defect in the Aged. John J. Kelly, Jr., and Harold A. Lyons. Ann. Int. Med. **48:** 267–283. February 1958. (J. J. K., Downstate Medical Center, 450 Clarkson Ave., Brooklyn 3, N. Y.)

Atrial septal defect is one of the most common forms of congenital heart disease. A series of 19 cases in patients over forty-five years of age seen over a four-year period is presented. During the same time, in this same age group, 3 other cases of congenital heart disease were found. The oldest patient of the series was seventy-six years of age, having survived two unrelated surgical procedures.

The clinical features are discussed in detail with a minute description of the auscultatory signs of atrial septal defect, primarily a pulmonic systolic murmur and a widely split second sound. The electrocardiographic features are discussed as well.

Radiography and fluoroscopy are extremely helpful in the diagnosis. Characteristically, the x-ray picture is that of cardiomegaly with marked enlargement of the right atrium and right ventricle. The left side of the heart is normal or small. The aorta is usually hypoplastic in the young, but often normal in the adult.

Increased pulmonary flow is reflected in an enlarged pulmonary vascular tree. The main pulmonary artery and its secondary and tertiary branches are dilated and tortuous, often with increased pulsation fluoroscopically. In pulmonary hypertension, only the tertiary branches are reduced in caliber. Venous angiocardiography was rarely considered helpful except in cases of significant right-to-left shunt with early opacification of the left atrium. Occasional demonstration of anomalous pulmonary venous drainage makes this procedure worthwhile, however.

Differential diagnosis from Lutembacher's syndrome is made by catheterization. If mitral stenosis is present, the end diastolic pressure of the left atrium is greater than the end diastolic pressure of the left ventricle. The cardiac catheterization findings in 9 of the authors' cases are described.

A long, active life is led by many patients with an atrial septal defect, with an average age at death of thirty-six. Associated anomalies play a more important role in early death than the septal defect. Frequent complications are respiratory infections, pulmonary hypertension, and thrombosis of the major pulmonary arteries. Less common complications are subacute bacterial endocarditis and cerebral abscesses resulting from septic emboli.

Eight illustrations, including 5 roentgenograms; 2 tables.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Chronic Cor Pulmonale and Its Treatment. W. Hadorn. Schweiz. med. Wchnschr. **88:** 1–6; 32–36, Jan. 4 and 11, 1958. (In German) (Medizinische Klinik der Unievrsität Bern, Switzerland)

The author discusses in detail chronic cor pulmonale due to pulmonary diseases which cause pulmonary hypertension with increased load on the right side of the heart producing dilatation of the right ventricle and finally right-sided insufficiency. A table of diseases causing chronic cor pulmonale is given.

The condition is of two types: (*a*) cor pulmonale due to diminished pulmonary circulation following chronic pulmonary diseases, either of alveolar or vascular origin, or due to deformities of the thoracic cage; (*b*) chronic cor pulmonale due to hypercirculation in the lesser circulation, with congenital or acquired heart disease, as well as following some neuromuscular diseases.

The physiology, pathology, and the clinical findings are discussed in detail. Pulmonary function studies, oxygen and CO_2 values of the arterial blood, and detailed examination of the sputum are important for the diagnosis.

The x-ray findings are usually not contributory in the early stages. Only in advanced cases are there enlargement of the heart and dilatation of the main branches of the pulmonary artery.

The treatment of chronic cor pulmonale is designed to improve alveolar ventilation, which is done by decreasing pulmonary infection, as well as the institution of oxygen therapy and artificial respiration.

Twelve illustrations, including 4 roentgenograms; 4 tables.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

The Roentgen Manifestations of Pulmonary Hypertension. E. F. Van Epps. Am. J. Roentgenol. **79:** 241–250, February 1958. (University Hospitals, Iowa City, Iowa)

This article is limited to the roentgenologic evaluation of pulmonary artery pressure in mitral stenosis, although the author believes that a fairly accurate appraisal of the pulmonary artery pressure can be made in congenital heart disease as well. The roentgenographic findings are the same regardless of the cause of hypertension.

Pulmonary hypertension may be divided into active and passive forms. Passive hypertension is due to elevation of the pulmonary venous pressure and is associated with only moderate increase in pulmonary artery pressure. Active hypertension is the result of an increase in the pulmonary arteriolar resistance and is associated with considerable elevation in pressure in the pulmonary artery.

Preoperative and postoperative roentgenograms of 100 cases of mitral stenosis were studied and estimations of the pulmonary artery pressure were made. Such estimations are reasonably accurate in pressure ranges of 0 to 30 mm., 30 to 70 mm., and 70 mm. and over. These should be graded as normal, moderate, and severe, respectively.

In studies of the roentgenogram for evidence of pulmonary hypertension, the entire pulmonary vasculature must be scanned. The heart size, size of hilar vessels, and size of peripheral vessels alone do not mirror the level of the pressure. There is significant variation among patients who have the same pressure and degree of heart disease. The attenuation of the peripheral vessels, the loss of definition of the vessels, and the evidence of neovascularity must be utilized. "B-lines of Kerley" are indications of impending failure and do not correlate well with the degree of pulmonary hypertentension in mitral stenosis. They are rare in congenital heart disease.

Eighteen roentgenograms.

ROBERT S. ORMOND, M.D.
Dearborn, Mich.

Left Atrial Electrokymography in Mitral Insufficiency in Man. A Correlative Study by Angiocardiography and Left Heart Catheterization. Richard D. Judge, Melvin M. Figley, and Herbert E. Sloan. Circulation **17:** 213–224, February 1958. (R. D. J., Department of Medicine, University of Michigan, Ann Arbor, Mich.)

To replace the discredited sign of systolic expansion of the left atrium in the recognition of mitral insufficiency, the authors present the sign of early diastolic collapse of the atrium. Early diastolic collapse is seen in tracings of normal hearts and actualiy indicates a lack of obstruction to the flow of blood from the atrium to the ventricle. If this sign is present on tracings of a heart with known mitral disease, it means that there is no significant stenosis of the valve. After demonstrating the sign in animals with experimental mitral insufficiency, the authors studied electrokymographic tracings of 44 cases of mitral disease which had been verified surgically. In 42 of the 44 they were able to predict correctly the predominant lesion (33 stenosis; 9 insufficiency). In the other 2 there were associated aortic lesions which caused slow emptying of the atrium, simulating mitral stenosis on the tracing.

Nine electrokymograms; 2 tracings.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Ventricular Precontracting Area in the Wolff-Parkinson-White Syndrome; Demonstration in Man. Giulio Bandiera and Pier Fausto Antognetti. Circulation **17:** 225–231, February 1958. (Medical Clinic of the University, Genoa, Italy)

In 8 of 11 cases of Wolff-Parkinson White syndrome the authors were able to demonstrate for the first time by roentgenkymography the actual area of myocardium which initiates the ventricular contraction before the normal impulse arrives from the SA node *via* the Purkinje network. On the kymograms the rest of the myocardium was seen to contract a short time after the precontracting area. ECG's and phonocardiograms were done simultaneously. In the A type (positive QRS in V_1, V_E, V_2) of the syndrome the area was found high in the left ventricle; in the B type (negative QRS in V_1, V_E, V_2), high in the right ventricle.

Twelve illustrations.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Double-Contrast Procedure for Angiocardiography. J. R. Blickman. J. belge de radiol. **41:** 33–36, 1958. (In Dutch) (Department of Therapeutics, University of Amsterdam, Netherlands)

Stauffer and his associates in the United States first suggested the use of carbon dioxide as a contrast medium for angiocardiography (Radiology **66:** 686, 1956), and Grosse-Brockhoff *et al.* of Germany also reported its use (Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 285, 1957. Abst. in Radiology **70:** 124, 1958). The present paper reports preliminary animal experiments from the Netherlands. The technic comprised heart catheterization followed by intracardiac injection of both carbon dioxide (up to 100 c.c.) and an iodinated contrast medium (10 c.c. Pyelombrin 60 per cent). Since the gas disappears quite speedily, seriography is necessary to obtain adequate roentgenograms. The method was employed 23 times on 12 dogs, without demonstrable untoward reactions.

Five roentgenograms; 3 photographs; 1 drawing.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Surgical Experiences in the Treatment of Aneurysms of the Thoracic Aorta. F. Henry Ellis, Jr., John W. Kirklin, and André J. Bruwer. Surg., Gynec. & Obst. **106:** 179–192, February 1958. (Mayo Clinic, Rochester, Minn.)

The authors present the results in 20 cases of thoracic aortic aneurysm treated surgically. Of these, 15 (75 per cent) were considered resectable. Four aneurysms that involved the proximal or transverse portion of the aortic arch were not subjected to resection because of the danger of interference with the cerebral blood flow. A fifth was believed on exploration to be too close to the left common carotid to permit safe excision, but was subsequently successfully removed elsewhere. The types of aneurysms were: arteriosclerotic 7, syphilitic 5, traumatic 3, congenital 2, mycotic 2, and dissecting 1. The patients ranged in age from five to seventy-two years, two-thirds being in the sixth, seventh and eighth decades.

Symptoms were often present, but not diagnostic. These included pain and thoracic discomfort, cough, dyspnea, hoarseness, and dysphagia. The diagnosis rests on the interpretation of routine roentgenograms of the thorax and the proper use of ancillary roentgen methods. In the present series with involvement of the distal part of the aortic arch and the descending aorta, upright roentgenograms taken at multip.e angles, either in the right posterior oblique or left anterior oblique projection, were particularly valuable in clarifying the nature and location of the lesion. These views are profitably supplemented by one or two right anterior oblique views, a lateral view, and a postero-anterior projection taken with Bucky technic. For study of the ascending aorta and proximal portion of the arch, retrograde aortic catheterization and aortography are

particularly useful. In patients who are not very large, the simpler method of venous angiocardiography may yield excellent results. The roentgen studies also aid in determining operability by demonstrating the relation of the aneurysm to the major vessels of the aortic arch.

The operative procedure of choice is excision of the diseased portion of the aorta with insertion of a graft. Homologous grafts were used in 12 of the authors' cases and polyvinyl formal grafts in 2 cases.

There were 5 deaths among the 15 patients undergoing resection. The 10 surviving patients had been followed for twelve to thirty months and with one exception had done well.

The authors conclude that, despite the high mortality rate of 33.3 per cent, surgical treatment must be considered in patients with aortic aneurysm, due to the extremely poor prognosis of untreated cases.

Four case reports are given, and the article is well illustrated with 12 roentgenograms, 10 photographs, and 2 diagrams. WALLACE MILLER, M.D.
University of Pennsylvania

Retrograde Aortography by Percutaneous Femoral Catheterisation. K. M. Pillai. Indian J. Radiol. **12:** 1-6, February 1958. (Government General Hospital, Madras, India)

This article is a general and fundamental one, presenting the indications, technics, and results of percutaneous femoral catheterization for retrograde aortography. The author's technic, as used in 50 patients, is described. No severe adverse reactions occurred. The contrast agent was 70 per cent Diodone or 70 per cent Diaginol. Advantages of percutaneous catheterization methods over translumbar aortography are pointed out, notably the ease with which the patient can be moved on the table into desired positions for radiography. The writer believes carefully performed retrograde aortography carries no greater risk than routine intravenous urography.

Eleven roentgenograms are presented to demonstrate various lesions found in the author's series. The reproductions are small and not of a quality to be very helpful. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Fatal Nephropathy and Adrenal Necrosis after Translumbar Aortography. M. J. Ciccantelli, William B. Gallagher, F. C. Skemp, and P. C. Dietz. New England J. Med. **258:** 433–435, Feb. 27, 1958. (St. Francis Hospital, La Crosse, Wisc.)

A 49-year-old laborer was studied for occlusive disease of the terminal aorta. Translumbar aortography was performed after testing for sensitivity with a 1 c.c. intravenous dose of the medium, sodium acetrizoate. An 18-cm. needle was inserted into the aorta just above the renal arteries with the patient under light anesthesia with thiopental sodium. Two successive injections of 70 per cent sodium acetrizoate were given, each of 50 c.c. Narrowing of the terminal aorta and common iliacs was demonstrated.

The patient suffered from severe nausea and vomiting for twenty-four hours after the procedure. He was anuric from the time of the procedure till his death five days later.

Autopsy revealed evidence of multiple minute vascular thrombi and arteriolar fibrinoid necrosis involving kidneys, adrenals, and pancreas. The pathogenesis is tentatively explained on the basis of a direct toxic effect of a high concentration of an iodine preparation delivered to visceral branches immediately adjacent to the site of puncture.

Precautions to be observed are: (1) choice of an injection site well above the origin of the renal arteries, (2) limitation of the amount of opaque medium to 40 c.c. or less, (3) local anesthesia and intra-aortic procaine to relieve vasospasm, (4) substitution of less toxic sodium diatrizoate (Hypaque).

One table. JOHN F. RIESSER, M.D.
Springfield, Ohio

Asymmetry of the Pulmonary Arteries. H. Schmitz and P. Thurn. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 133–145, February 1958. (In German) (Med. Universitätsklinik Bonn, Germany)

For recognition of typical asymmetry of pulmonary arteries an ordinary roentgenogram of the chest is sufficient. Tomography is helpful for additional information, but angiocardiography is needed only in exceptional cases.

Asymmetry of pulmonary arteries is either congenital or acquired. The congenital type is usually seen in association with congenital heart disease and rarely represents an isolated anomaly. The acquired type can develop on the basis of chronic inflammatory changes or is due to primary disease of the lungs and bronchi.

The authors' material consists of 30 cases with predominantly unilateral changes. In 20 cases the asymmetry was due to congenital heart disease (tetralogy and trilogy of Fallot, isolated pulmonic stenosis, and pseudotruncus arteriosus); in only 2 cases could an isolated anomaly be found. Development of a thrombotic closure of a pulmonary artery was observed in 1 instance.

The roentgen findings are more or less the same in the congenital and the acquired type, consisting of unilateral narrowing of central and peripheral arteries, small hilar shadows, and increased radiolucency of the affected lung, simulating unilateral emphysema. Inconstant findings are asymmetry of the thorax with retraction of the involved side, elevation of the hemidiaphragm, and mediastinal shift. The contralateral hilar and pulmonary markings frequently show increased prominence, which suggests hyperemia rather than true pulmonary congestion.

In the differential diagnosis, pulmonary emphysema can be excluded because of absence of mediastinal shift and presence of bilateral changes with large hilar densities, low diaphragm, and thoracic expansion. Only in the acquired asymmetry of pulmonary arteries due to bullous emphysema does one find a low diaphragm and mediastinal shift to the contralateral side, also a normal or enlarged hilar density. A unilateral pneumothorax can be excluded by absence of the border line of a compressed lung.

Twenty-one roentgenograms; 2 tables.
ERNEST KRAFT, M.D.
Northport, N. Y.

Laboratory Studies in the Evaluation of Postphlebitic Disease. W. G. Anlyan, J. K. Isley, J. F. Schauble, G. J. Baylin, and R. W. Postlethwait. Arch. Surg. **76:** 228–237, February 1958. (Duke University School of Medicine, Durham, N. C.)

In an effort to develop better technics for evaluating the veins of the legs after phlebitis, the authors per-

formed three tests on each of 40 patients. Venography, venous pressure determinations, and radioactive isotope outflow studies were carried out in most cases on both legs.

The pressure studies proved to be of limited usefulness. Among normal controls and patients with primary varicosis, pressures dropped with exercise. With deep venous occlusive disease, however, the pressures showed unpredictable wide variations. In 4 of 7 patients who had vena cava ligations, no pressure changes were observed during or after the procedure.

In the isotope studies, radioactive Diodrast was injected into the dorsalis pedis vein and counts were made over the popliteal vein, the sapheno-femoral junction, and the inferior vena cava. There was slowing of the venous outflow from the lower extremity in patients with primary varicosities and after phlebitis. The normal circulation time was from 10.4 to 15.6 seconds between the dorsalis pedis vein and the inferior vena cava to the right of the umbilicus. The ultimate usefulness of the test is not yet established.

The venograms were made by injecting contrast medium into the long saphenous vein at the ankle. This has proved to be a simple means of evaluating the veins and is useful in determining the degree of deep venous occlusion, or in differentiating between primary varicose veins and postphlebitic incompetent superficial collaterals.

One source of error to be guarded against is assumption that venous nonfilling indicates venous disease. The study should not be performed in the presence of acute venous thromboembolism or when there is cellulitis in the leg.

Sixteen figures, including 7 roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

THE BREAST

Roentgenography of Unsuspected Carcinoma of Breast. Jacob Gershon-Cohen and Helen Ingleby. J.A.M.A. **166:** 869–873, Feb. 22, 1958. (255 S. 17th St., Philadelphia 3, Penna.)

Unsuspected carcinomas of the breast fall into the following categories: (1) cancers resembling benign lesions, smooth and freely movable clinically, and sometimes multiple in occurrence; (2) nodular breasts with no dominant mass; (3) localized thickening or some unusual sensation which arouses suspicion in the absence of a palpable mass; (4) cases with no symptoms or physical findings. A series of more than 1,500 women with breast lesions were examined radiographically by the authors. The x-ray examination revealed a percentage of accuracy almost twice as great as that obtained by clinical examinations. Occult carcinomas as small as 0.5 cm. in diameter were demonstrable. The authors feel that x-ray examination is mandatory in all women presenting vague, unusual, or unaccountable breast symptoms, since the finding of small unsuspected carcinomas offers the best prospect for cure.

The x-ray appearance varies with the type of tumor. The differential diagnosis of cyst and carcinoma is usually fairly simple because of spiculation of at least one margin in cancer. Among multiple fluffy areas of adenosis, a carcinoma may appear more dense, particularly if of a scirrhous type. Duct carcinomas rarely show a definite outline but usually there are one or more clusters of minute calcific particles in the region of the mass, and frequently along the line of the ducts.

Seven roentgenograms.

CAPT. NEIL E. CROW, M.C.
Parks AFB, Calif.

THE DIGESTIVE SYSTEM

Carcinoma of the Esophagus. David P. Boyd, Herbert D. Adams, and Ferdinand A. Salzman. New England J. Med. **258:** 271–274, Feb. 6, 1958. (New England Baptist Hospital, Boston, Mass.)

Report is made of 124 cases of carcinoma of the esophagus in which exploratory operations were done in the period 1950 to 1955. Direct extension and involvement of neighboring lymph nodes were demonstrable in 68 per cent of the authors' cases. Forty-one patients whose tumors arose above the level of the aortic arch showed 39 per cent postoperative deaths; fifty-four patients with tumors arising below the aortic arch showed an operative mortality of 17 per cent. Of the cases in which resection was done, only 8 per cent survived for five years. Because of these low survival figures, the authors have added supervoltage irradiation to their treatment methods. Three of 13 patients who received combined surgery and postoperative irradiation had survived for an average of fifty months at the time of this report.

The authors conclude that, even though their series is too small to have statistical significance, it does suggest that greater salvage may be obtained by combined procedures. Primary surgical resection and anastomosis of the esophagus is the treatment of choice when it can be accomplished but is supplemented by postoperative radiotherapy if the question of residual tumor arises. General results in the group of cases studied are presented in tabular form. No details of surgical or radiotherapeutic technics are given.

Seven roentgenograms; 3 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Contribution to the Study of Traction Diverticula of the Esophagus. M. E. Machado Macedo. Schweiz. med. Wchnschr. **87:** 861–864, June 29, 1957. (In French) (Service de Chirurgie Thoracique des Hôpitaux de la Ville de Lisbonne, Hôpital "dos Capuchos," Lisbon, Portugal)

Diverticula of the proximal third of the esophagus are designated pharyngo-esophageal; of the middle third, epibronchial; and of the distal third, epiphrenic. In the upper and lower thirds, pulsion is the main pathogenetic factor, while in the middle third traction is the most frequent cause. Actually, this last factor is the contraction of the scar resulting from an inflammatory process which has invaded the esophageal wall, usually a neighboring tuberculous adenopathy.

One illustrative case of middle-third esophageal diverticulum is presented, with the statement that, though conservative management should be advised, at least when the patient is first seen, surgical removal is definitely indicated in cases with persistent or disturbing symptoms. In this case, tuberculous infection pre-existed (therapeutic pneumothorax was discontinued and specific chemotherapy was instituted prior to successful diverticulectomy), and therefore, even when an anteriorly located diverticulum of the middle third

of the esophagus resembles a rounded pouch, pulsion is only a contributing factor, and traction remains the main cause.

Thirteen roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Esophagobronchial Fistula Due to Esophageal Traction Diverticulum. Review of Literature and Report of Case. William R. C. Stewart, Karl P. Klassen, and Alexander P. Horava. Arch. Surg. **76:** 317–321, February 1958. (Ohio State University Health Center, Columbus, Ohio)

Traction diverticula are most commonly found on the lateral wall of the esophagus at about the level of the hilus of the lung. There evidently is an initial formation of adhesions between the esophagus and the peribronchial lymph nodes, probably based upon inflammation. The adhesions contract, creating an outpouching of the esophageal wall. Although they originally contain all muscle coats, later, as a result of pulsive forces, they may be made up only of mucosa. Should one of these diverticula perforate, a fistula leading to the trachea or a bronchus may result. Only 21 cases of this sort have been reported, and in many instances the diagnosis has been dependent upon x-ray findings.

The authors present a case in which barium swallowed during an upper gastrointestinal examination was noted to pass from the esophagus into the bronchus of the superior segment of the right lower lobe. A Lipiodol swallow demonstrated a communication between a diverticulum arising from the right lateral wall of the midesophagus and the bronchus. Esophagoscopy revealed a small midesophageal opening which opened and closed with respiration. This was found later at surgery to be at the apex of a diverticulum, 3 cm. in length, evidently secondary to mediastinal lymphadenitis of nontuberculous origin. There was bronchiectasis in the lobe supplied by the involved bronchus. Surgical excision of the lung segment and of the diverticulum was carried out. Symptoms related to the fistula in this case had been present for twenty-one years before the diagnosis was made and treatment instituted.

Emphasis is given to the point that preoperative chest films and bronchograms are needed to help determine the extent of the resection.

Two roentgenograms; 1 photomicrograph.
DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Congenital Malformations of the Esophagus, Stomach, and Duodenum in Infants. R. Guichard and G. Delorme. J. de radiol. **39:** 13–27, January-February 1958. (In French) (Bordeaux, France)

This is a review article which discusses the congenital malformations involving the upper gastrointestinal tract in considerable detail. Included are various forms of esophageal atresia, short esophagus, cysts, varices, megaesophagus, diverticula, diaphragmatic hernia, malformations around the cardia and gastric fundus, hypertrophic pyloric stenosis, duodenal malformations and stenoses. The relation of esophagitis to regurgitation and shortening of the esophagus is again presented.

Most of the lesions under discussion are of urgent nature and roentgen contrast studies should be done early to aid in diagnosis and subsequent handling of the patients. CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

The X-Ray Examination of the Stomach. Frederic E. Templeton. Gastroenterology **34:** 248–253, February 1958. (415 Cobb Bldg., Seattle 1, Wash.)

Gastric Ulcer and Cancer. Sara M. Jordan. Ibid. pp. 254–268. (605 Commonwealth Ave., Boston, Mass.)

Life Cycle of Regional Ileitis. Burrill B. Crohn. Ibid. pp. 300–305. (1075 Park Ave., New York 28, N. Y.)

The papers listed above, of radiological interest, are included in a group of postgraduate courses presented at the Annual Meeting of the American Gastroenterological Association, in co-operation with the University of Colorado School of Medicine, in 1957. Other courses are to be published in subsequent issues of *Gastroenterology*, and the entire group will be available in the form of a monograph.

These courses were given solely for the purpose of instruction and do not lend themselves to abstracting. Anyone interested in a review of the various subjects might find them helpful.

Double-Contrast Roentgenography of the Stomach. A Study on the Applicability of Direct Air Insufflation in Gastric Diagnosis. M. Eiken. Acta radiol. **49:** 96–104, February 1958. (Københavns Amts Sygehus, Gentofte, Denmark)

The technic used in the series of studies reported here consisted of the introduction of a nasogastric tube into the stomach followed by the administration of 15 to 30 c.c. of barium. The patient is placed in various positions to insure adequate coating of the stomach. Air is then injected through the tube, under fluoroscopic control, in amounts sufficient to flatten out the rugal folds of the stomach. For this purpose, from 1,200 to 1,600 ml. of air is considered adequate. Barium of a relatively high viscosity is used.

Ninety-four examinations were done on 92 patients, in all but 6 instances after routine examinations of the stomach which had raised the suspicion of organic gastric changes.

Twenty-two gastric tumors were discovered, of which 12 were confirmed by operation and 6 by autopsy. In 2 others gastroscopic examinations supported the radiologic diagnosis. One patient, in whom examination had revealed a tumor of the cardia involving the esophagus, died with signs of esophageal cancer, and 1 case was lost to follow-up.

Apart from 1 case in which the tumor was quite definitely demonstrated by routine examination, the double-contrast procedure gave more accurate information regarding location and extent of the tumor. In 4 cases, the routine examination was normal but the clinical symptoms led to performance of the double contrast study.

In 12 of 13 cases in which the presence of tumor was strongly suspected on routine examination double-contrast study revealed a normal stomach. In the remaining case an extragastric mass was revealed which at subsequent operation was found to be a pancreatic tumor.

In a few cases, ulcers of the anterior or posterior walls, and hiatal herniae were demonstrated, which were not found on routine examination.

The author feels that double-contrast examination of the stomach is indicated where there is doubt as to the diagnosis after routine examination.

Seven roentgenograms. HOWARD GOULD, M.D.
St. Vincent's Hospital, New York

Antiperistalsis of the Stomach in Extragastric Non-Stenosing Lesions. E. Zdansky. Schweiz. med. Wchnschr. **87:** 1423, Nov. 23, 1957. (In German) (Institut für Röntgendiagnostik und Strahlentherapie der Universität Basel, Switzerland)

Antiperistalsis of the stomach, when demonstrable fluoroscopically, is significant and should always be considered as serious. It points to an anatomical process which may be in the stomach itself, but not always to pyloric stenosis. It may be associated with nonstenosing duodenal ulcer but also occurs with inflammatory or neoplastic processes in the gallbladder or pancreas. It may be the only indirect sign pointing to diseases of these latter organs.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

Peutz-Jeghers Syndrome. D. Cottone and N. Aquila. Radiol. med., Milan **44:** 113–125, February 1958. (In Italian) (Istituto di Patologia Chirurgica dell'Università di Palermo, Italy)

About 50 cases of familial (hereditary) gastrointestinal polyposis associated with cutaneous and mucosal micropigmentation (Peutz-Jeghers syndrome) have been reported in the literature. A case is presented in this paper, along with a brief review of previous publications on the subject.

The patient, a 29-year-old female, was submitted to exploration, with removal of a polypoid mass from the ileum (the appendix was extirpated at the same time, because it contained coproliths). Knowledge of the existence of this entity should further its recognition in the future, and one may predict that it will be encountered with increasing frequency.

Fifteen illustrations, including 8 roentgenograms and 4 photographs in color. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Operative Intestinal Arteriography. Robert Schobinger, George E. Blackman, and Ru Kan Lin. Ann. Surg. **147:** 224–231, February 1958. (Roswell Park Memorial Institute, Buffalo 3, N. Y.)

Angiography is rapidly increasing in popularity and may be properly considered an integral part of the present diagnostic armamentarium. The authors present a detailed discussion of a method performed during surgery, permitting a detailed angiographic evaluation of segments of the large intestinal tract.

The patient is properly centered over a Potter-Bucky diaphragm and, after incision and dissection, the main artery to be injected and its principal branches are isolated at their origin. A catheter is introduced into the main artery just proximal to the origin of the first branch, and fixed by ligature.

Approximately 10 to 15 c.c. of an opaque contrast medium is rapidly injected, and a film is exposed during the injection of the last 1 or 2 c.c. The films are read wet.

The authors' experience at the time of their report was limited to injections into the inferior and branches of the superior mesenteric arteries. They conclude:

1. Operative intestinal arteriography is a technically simple and relatively safe procedure.

2. The vascular pattern of normal intestine is more or less uniform within a given vascular territory.

3. Operative intestinal arteriography tends to substantiate the presence of abnormal vessels, puddling of contrast medium, and delayed venous drainage in adenocarcinoma of the large intestine.

4. The entire contour of a neoplasm may be demonstrated.

5. Benign adenomatous polyps are characterized by foci of increased radiopacity.

6. Even very small polypoid formations may be identified with operative intestinal arteriography.

7. The collateral blood supply of large segments of the intestine can be evaluated.

Three sets of roentgenograms; 4 photographs.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Annular Pancreas Producing Duodenal Obstruction in the Newborn. Report of Three Cases. Donald Weatherill, Edward G. Forgrave, and William S. Carpenter. J. Dis. Child. **95:** 202–205, February 1958. (Mount Carmel Mercy Hospital, Detroit 35, Mich.)

Three cases of annular pancreas producing duodenal obstruction in newborn infants seen during a two-month period are reported. In 2 cases the diagnosis was made at operation, in the third case at autopsy.

In contrast to the picture in the adult, in whom duodenal obstruction is rare and evidence of annular pancreas is often vague and nonspecific epigastric distress, the most constant and dramatic symptom in the newborn is duodenal obstruction. In the cases reported this was complete. In the presence of such obstruction, vomiting occurs on the first or second day of life and continues thereafter. The vomitus usually contains bile, but this will depend upon the location of the obstruction in relation to the ampulla of Vater.

The diagnosis of duodenal obstruction can frequently be made by simple x-ray examination of the abdomen. The presence of a gas-filled stomach and duodenum without evidence of gas elsewhere is diagnostic. Any infant who vomits during the first day or two of life should have the benefit of such examination if an early diagnosis is to be made. The differential diagnosis between annular pancreas and duodenal atresia will usually not be possible, but from a surgical standpoint it is of little importance. Further roentgenograms with a radiopaque substance may be desirable in some cases.

Early diagnosis and surgical intervention are essential if the infant is to survive. A by-pass operation (duodenojejunostomy) is the procedure of choice.

THEODORE E. KEATS, M.D.
University of Missouri

The Cholecystogram and the Clinician. J. Dudfield Rose. Brit. M. J. **1:** 360–362, Feb. 15, 1958. (Newcastle General Hospital, England)

The author states that "classical" cholecystography does not reveal important information regarding motor dysfunction and morphological abnormalities of the gallbladder, which are often the cause of biliary symptoms. The technic he uses includes anteroposterior and lateral views fourteen hours after ingestion of a single dose of Telepaque and then, after a fatty meal, serial films every ten minutes for eighty minutes. From these studies two curves are drawn. One shows the volume of the gallbladder and the second shows its angle of erection, *i.e.*, the angle between the long axis of the gallbladder and that of the spinal column in the lateral view. Normally this is between 5 and 15°. The normal volume of the gallbladder is 25 to 30 c.c., with a decrease of 70 per cent in the first thirty minutes after the fatty meal.

In abnormal states the gallbladder may empty in-

sufficiently (hypokinesia) or excessively (hyperkinesia). The gallbladder tone, as indicated by the angle of erection, may be less than normal (hypotonic) or greater than normal (hypertonic).

The author studied 137 patients with biliary disorders by the technic described. In 40 the "classical" cholecystogram was normal, but serial cholecystography showed a dyskinesia, later proved at operation. The most common finding was vesicular stasis, due to muscular atony. Twenty such cases were treated by right splanchnicectomy with good results. Lack of emptying may be due to obstruction of the neck of the gallbladder or cystic duct due to spasm of the sphincter of Lütkens (7 cases), to fibrosis of the cystic duct, or other cause. In the 7 cases where spasm of the sphincter of Lütkens was diagnosed vagotomy gave good results.

Preoperatively the diagnosis of the cause of dyskinesia is confirmed by manometry and radiography in the operating room.

Two drawings; 8 charts. J. S. ARAJ, M.D.
Toledo, Ohio

Polypoid Mucosal Lesions of Gallbladder. G. M. Carrera and Seymour Fiske Ochsner. J.A.M.A. **166:** 888–892, Feb. 22, 1958. (G. M. C., 3503 Prytania St., New Orleans 15, La.)

Polypoid lesions of the gallbladder mucosa were found in 28 of 1,331 cholecystectomies. These included inflammatory polyp, cholesterol polyp, papillary adenomas, polypoid adenomyoma, and carcinoma *in situ*. Mucosal lesions can usually be differentiated roentgenographically from radiolucent gallstones by the following features: (1) The gallbladder is ordinarily well visualized, although function may be impaired by concomitant cholelithiasis or cholecystitis. (2) The radiolucent defect produced by these lesions is usually 2 to 3 mm. in diameter and rarely exceeds 5 mm. (3) The radiolucent shadow is usually rounded, with smooth or slightly irregular edges. (4) It maintains a constant position in the gallbladder. Optimum visualization is obtained after the gallbladder has contracted in response to a fatty meal.

These polypoid growths are small and soft and are easily torn from their pedicles. Consequently, palpation at surgery, without resection or exploration of the gallbladder, may fail to demonstrate a small but roentgen-apparent polyp. Since there is reason to regard gallbladder polyps as potentially malignant, the authors believe that it is wise to consider cholecystectomy when there is radiographic evidence of such a lesion, unless there are definite contraindications.

Four roentgenograms; 4 photomicrographs.
CAPT. BYRON G. BROGDON, M.C.
Parks AFB, Calif.

Postcholecystectomy Syndrome, with Special Reference to the Cystic Duct Remnant. Maurice Feldman. Gastroenterology **34:** 239–246, February 1958. (3602 Fords Lane, Baltimore 15, Md.)

Recurrence of symptoms following cholecystectomy (postcholecystectomy syndrome) occurs in 20 to 40 per cent of cholecystectomized patients. In 271 collected postcholecystectomy cases, a cystic duct remnant or stump was demonstrated in 38 (14 per cent) by intravenous cholangiography (with 40 c.c. of 20 per cent Cholografin). Demonstration of the cystic duct stump does not in itself indicate that the remnant is responsible for the postcholecystectomy syndrome. Symptoms, however, may be produced by the stump if it (1) enlarges and exerts pressure on the biliary tract, (2) kinks the common duct by traction, (3) contains calculi, (4) is the seat of inflammatory changes, or (5) is the site of an amputation neuroma. The length of the stump may vary from 0.5 to 12 cm. and its diameter from 0.5 to 6 cm., the larger diameters being found in instances of bulbous dilatation. (These measurements are based primarily on the cholangiographic study of 294 cases of cystic duct remnant by Millbourn: Acta chir. scandinav. **100:** 448, 1950.)

A majority of cystic duct stumps show inflammatory changes of varying degree, and these changes, together with the large mucosal folds of the proximal cystic duct, favor the formation and retention of calculi. The incidence of stones within the cystic duct remnant was 27 per cent in 314 collected reoperated cases of postcholecystectomy syndrome. Nineteen cases of postcholecystectomy syndrome due to amputation neuroma of the cystic duct stump were collected from the literature. Rarer complications include herniation of a dilated stump into the lesser peritoneal sac and formation of a mucocele distal to an impacted stone.

Cholecystectomy should include resection of the cystic duct as close to its junction with the common bile duct as possible in order to prevent formation of a pathologic cystic duct stump.

Retained common and hepatic duct stones are other causes of the postcholecystectomy syndrome. There is controversy concerning the importance of biliary dyskinesia and common duct dilatation as factors in production of this syndrome. SAMUEL B. HAVESON, M.D.
University of California, S. F.

Postoperative Cholangiography Partially Performed with the Patient in the Upright Position. Anthony G. Boreadis and J. Gershon-Cohen. Surg., Gynec. & Obst. **106:** 242–244, February 1958. (Albert Einstein Medical Center, Northern Division, Philadelphia 41, Penna.)

The authors describe a cholangiographic technic which utilizes a belt-like arrangement to hold the syringe containing the contrast material in place. With this arrangement, the proximal portions of the biliary system are visualized in the Trendelenburg position and upright spot and regular films are then taken to demonstrate the distal portions of the biliary tree. Two to four cubic centimeters of contrast material (50 per cent water-soluble) are introduced, with an additional 0.5 c.c. before each film.

The authors feel that the advantages of this arrangement include better visualization of the intraduodenal portion of the distal duct, less chance of confusion by air bubbles in the biliary tree, and avoidance of repeat studies because of more conclusive results.

Six roentgenograms; 2 photographs.
MARK M. MISHKIN, M.D.
University of Pennsylvania

The Amplifying Fluoroscope. Comparison with Conventional Fluoroscope in Two Thousand Examinations of the Stomach. Homer V. Hartzell and Wayne A. Chesledon. J.A.M.A. **166:** 759–761, Feb. 15, 1958. (306 Stimson Bldg., Seattle 1, Wash.)

A study was made of 2,000 gastrointestinal series in a private office, comparing 1,000 examinations prior to installation of an image amplifier and 1,000 examinations afterwards.

The authors found that lesions were detected with equal ease when either the conventional or amplifying fluoroscope was used, provided adequate spot-films were obtained. They point out advantages of the amplifier, which they feel completely justify its use, as follows: (1) certainty of fluoroscopic findings; (2) decreased radiation; (3) no dark adaptation; (4) ease and speed of examination.

Reputed disadvantages of the amplifier are: (1) small size of field; (2) bulkiness; (3) cost; (4) possible future obsolescence. The authors feel that these objections are not entirely valid, and should not preclude purchase or use of the device in the private office.

Thirty-three roentgenograms; 1 graph; 1 table.

CAPT. BYRON G. BROGDON, M.C.
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HERNIA

Hiatus Hernia: Its Incidence and Clinical Significance. E. Hafter. German M. Monthly **3:** 1–4, January 1958. (Tödistr. 36, Zurich, Switzerland)

The author describes the radiological features, symptoms, and treatment of hiatus hernia, based on an analysis of his 300 cases. The symptoms fall in three main groups; those localized to the retroxiphoid or epigastric area, those due to incompetence of the cardia, and those due to secondary involvement of the esophagus (reflex esophagitis). Only 3.7 per cent of the patients were asymptomatic.

The author mentions four requirements for an adequate radiological demonstration of hiatus hernia.

(*a*) The lower end of the esophagus and the cardia must be filled with barium at the time of exposure.

(*b*) The examination must be carried out with the patient in the horizontal position.

(*c*) The contents of a spontaneously reducible hernia must be made to pass through the hiatus into the thorax by posturing or by raising intra-abdominal pressure.

(*d*) The exposure must be made during expiration to avoid confusion with the epiphrenic ampulla.

Three views are routinely used for demonstrating the hernia. The right anterior oblique prone projection demonstrated the hernia in 60.7 per cent of the 300 cases. Spontaneously reducible hernias are often missed by this method. The prone position, with epigastric compression by balloon or pillow, produced positive results in 94.7 per cent of the series. The third view is that obtained in the left oblique supine Trendelenburg position (right side up).

Indirect radiological signs suggesting hiatus hernia include passage of barium into the stomach during maximum inspiration, esophageal reflux and S-shaped tortuosity of the distal end of the esophagus, and irregularity of its mucosa.

Eleven roentgenograms; 4 tables.

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THE MUSCULOSKELETAL SYSTEM

Roentgen Manifestations of Adult Rheumatoid Arthritis, with Special Regard to the Early Changes. Pekka Soila. Acta rheumatol. scandinav., Suppl. 1, 1958. (Hospital of the Rheumatism Foundation, Heinola, Finland)

Three thousand five hundred patients with a diagnosis of rheumatoid arthritis, treated in the 317-bed Rheumatism Foundation Hospital at Heinola, Finland, form the population whose roentgenograms have been studied by the author. Of these, 407 men and 625 women were selected for careful x-ray examination of the following areas: (1) hands and wrists, (2) metatarsal bones and toes (called the forefeet), (3) ankle and tarsal bones, and (4) knees. In order to focus attention on the early stages of the disease, only those patients were selected for study in whom the duration of the condition was less than six years. In order to provide a more homogeneous age distribution the study was arbitrarily given a lower limit of twenty years and an upper of forty-nine in men and forty-six in women. Films of the hands were obtained for all 1,032 patients, but of the forefeet in only 440, ankles in 283, and knees in 368, because examinations were carried out only when clinical changes were present in the relevant areas.

The technics were standardized as well as possible, at low kilovoltages, short exposure times, maximum current output, and nonscreen films for all views except the knees. The resulting roentgenograms were analyzed, and the results classified, according to the following eleven criteria:

1. *Soft-tissue changes* were strongly manifest in the hands from the beginning of the observation period throughout the course of the illness. Changes were found with significantly diminishing frequency in the forefeet and then in the ankles. Since knee films exposed for bone detail did not show soft-tissue changes well, no statistical studies were made of these joints.

Fusiform enlargements of the outlines of the fingers were common, particularly at the proximal interphalangeal joints. In the ankle the most important manifestation of early disease was swelling of the adjoining soft tissues and a dorsal shift of the Achilles tendon. The ankle findings occurred more frequently in women than in men.

2. *Calcium content changes.* A loss of calcium compounds in the trabeculae produced an increase in transparency of the bones almost universally in the forefeet and ankles, and generally also in the hands and knees. Roentgenograms on healthy persons resembling the patients in sex, age, and size were used as controls in evaluation. Loss of calcium density was found in the initial stage near the joints of the hands. In more advanced disease the increase in transparency was more evenly distributed. A third type of calcium loss had a spotty distribution, most frequently seen at the wrists and often asymmetrical in the two members. In later stages of rheumatoid arthritis the calcium content was sometimes again increased. Increase in contrast sometimes appeared, especially in women, at the juxtaarticular portions of the phalanges and this, the author warns, should not be mistaken for evidence of enhanced density. Loss of calcium compounds in the knee was best recognized on lateral views at the anterior margin of the femur and in the patella. In the foot, ankle, and knee, calcium content changes were easily the most frequently recognizable abnormality.

3. *Joint space changes.* Both widening and narrowing of the joint space were manifest. The former was infrequent, and generally occurred in earlier stages of rheumatoid arthritis than did narrowing. Widening was not encountered at the ankles nor at the knees (except for withdrawal of the patella from the femur caused by joint swelling).

4. *Cysts.* The author defines cysts as transparent

areas of brightness bordered by bone tissue on all sides and located near the joint surface. These were found fairly frequently in the forefeet and hands and rather rarely in the ankles and knees. In the hands there was a highly significant greater incidence in women than in men; in the ankles a significantly greater incidence in men than in women.

5. *Erosion* was the result of breaking of the cortex, sometimes from enlargement of a cyst. Like cysts, erosions were most frequent in the hands and forefeet. An important early change is erosion in the calcaneus above the insertion of the Achilles tendon. The knee was found to be relatively resistant to erosion.

6. *Alignment changes* consisted of deviations and luxations. These occurred most frequently in the ankles and forefeet, less frequently in the hands, and to only a minor extent at the knees (except for surprisingly extensive dislocations of the patella).

7. *Periosteal changes.* A sign of early rheumatoid arthritis in the small bones was a slack appearance of the periosteum, which looked as if it were too long to surround the bone. At the ankles a thin periosteal swelling was sometimes seen in the frontal projection, but not in the lateral. No significant statistical differences were discernible in the distribution of lesions in the different parts (but the manifestations in the knees were insufficient for evaluation). There was no difference between the sexes. Periosteal changes were found to have no clear connection with other early changes, and their appearance was apparently coincidental.

8. *Bone deformations* took the form of new bone formation occurring at the borders of defects resulting from osseous destruction, and included loose ossicles. In women such changes occurred most frequently in the forefeet and almost as often in the hands, increasing significantly in both areas with duration of symptoms. In men the occurrence increased significantly in the hands but remained uniform in the other areas.

9. *Ankylosis.* Bony ankylosis is classed as an irreversible final manifestation of rheumatoid arthritis. Fibrotic ankylosis can be ascertained from limitations of movement of the joints. The observations were insufficient for statistical evaluation.

10. *Deformations and fusions in the carpal and tarsal areas* were put in a separate category because of the complexity of evaluation of the multiple articulations. The changes were found to begin at the points where natural mobility is slightest. Radiocarpal fusion was found to commence at the os lunatum, and to progress from the more central bones in both ulnar and radial directions. A very uniform increase in involvement was found, related to duration of symptoms in both sexes. The tarsus was found to be more resistant than the carpus to the described changes.

11. *Osteochondrosis* includes degenerative changes such as uneven narrowing of joint spaces, sclerosis of joint surfaces, and formation of marginal osteophytes. Such findings in the terminal interphalangeal joints were not considered to be related to rheumatoid arthritis. The roentgenographic diagnosis was made most frequently in the weight-bearing joints. In the ankle the changes were clearest and most frequent in the talonavicular joint. In the knee a lessening of calcium content, with disturbance of osseous structure, was found to be a much more valid early sign of rheumatoid arthritis than sclerosis.

A breakdown of the appearance of signs showed that in men all the joints tended to become uniformly involved, whereas in women the hands were more often affected than other parts. Many findings were more frequent in women than in men, notably cysts and erosions in the hands and bone deformations in the hands and forefeet.

Graphs showing the effect of the age at the onset of the disease disclosed a slight tendency toward a more abundant appearance of the changes as the age increased.

The author observed that the roentgenologic signs of rheumatoid arthritis could progress and regress side by side. While the disease remained active, however, the diagnostic findings were maintained (with the exception of periosteal changes). Roentgen examination is considered of prime importance in making the diagnosis of rheumatoid arthritis and in determining the phase of the disease in the variously involved areas.

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Western Reserve University

Hypophosphatasia. W. Dickson and R. H. Horrocks. J. Bone & Joint Surg., **40-B:** 64–74, February 1958. (Bolton Hospital Group, Bolton, England)

Since Rathbun described the first fatal case of hypophosphatasia in an infant in 1948 (Am. J. Dis. Child. **75:** 822, 1948. Abst. in Radiology **53:** 143, 1949), this syndrome, which resembles rickets but is marked by a low serum alkaline phosphatase, has been noted in children from infancy to puberty. The most severe cases occur in young infants and are usually fatal, probably as a result of associated renal disease.

The authors report a case in a boy of six years. Radiographically the skeleton was poorly mineralized, particularly about the metaphyses of the long bones and around the shoulder, knee, and wrist joints. At the knee the epiphyses were poorly calcified and the metaphyseal line irregular. The cupping of rickets was absent. The motheaten appearance of the metaphyses was most marked about the femoral epiphyses but was observed, in milder degree, around the wrists, shoulders, and elbows. The radius and ulna were bowed outward. The iliac bones were markedly decalcified. The skull was thin and presented a beaten-silver appearance due to craniostenosis, which appears to occur in this condition oftener than in the general population.

The literature is carefully reviewed. Clinical features may include a failure to thrive in infancy, premature loss of deciduous teeth, hypercalcemia, and renal damage. In addition to the low serum alkaline phosphatase level, recent studies indicate an excessive excretion of phosphoethanolamine in the urine.

Ten roentgenograms; 3 tables.

SAUL SCHEFF, M.D.
Boston, Mass.

Familial Metaphysial Dysplasia. J. E. A. David and P. E. S. Palmer. J. Bone & Joint Surg. **40-B:** 86–93, February 1958. (Bulawayo General Hospital, Bulawayo, Southern Rhodesia)

Familial metaphyseal dysplasia is a rare nondisabling, nonprogressive anomaly which depends upon radiology for its diagnosis. The changes consist in extreme widening of the metaphyseal ends of the long bones, with marked thinning of the cortex in the expanded areas; the mid-diaphyseal areas are usually within normal limits. All of the long bones, as well as the skull, may be affected. The base of the skull may

show marked expansion or merely an increase in density. Osteemalacia and a tendency to abnormal fragility have been reported but appear not to be essential features.

The author reports a case in a girl of eight years. Roentgenograms showed the spine, pelvis, and scapulae to be normal. The inner ends of the clavicles were symmetrically ballooned out, as were the anterior ends of the ribs. The mandible and the base of the skull were expanded but there was no increase in density. The midshafts of the radius and ulna were widened; also the same regions of the metatarsals, metacarpals, and phalanges.

A six-year-old sister of the patient had slight changes confined to the forearms and legs, and a half-brother (with the same father), aged fourteen, showed slight broadening of each radius and ulna. Other children in the family were normal. Two other cases in another family are briefly cited.

In the differential diagnosis one must consider osteopetrosis; Gaucher's disease, which is limited to the distal femurs; infantile cortical hyperostosis, with its limitation to young infants; hypothyroidism, in which the spine and the clinical appearance are diagnostic but clubbing of the bones may occur; localized diaphyseal aclasis, which is excluded by diffuses keletal involvement.

Eight roentgenograms; 1 photograph; 1 table.

SAUL SCHEFF, M.D.
Boston, Mass.

Contribution to the Radiologic Study of Periosteopathies. Giorgio Groppi. Ann. radiol. diag. **30**: 333–380, 1957. (In Italian) (Istituto di Radiologia e Terapia Fisica dell'Università di Pavia, Italy)

This extensive review is based on the "Italian" classification of the causes which may produce periosteal proliferation. The generic term "periosteopathies" is used to allow separation into "ossifying periostitis" of inflammatory origin and the noninfectious "ossifying periostosis."

"Ossifying periostitis" includes both nonspecific and specific types. Among the former are acute and chronic osteomyelitis, albuminous osteoperiostitis, Brodie's abscess, Garré's osteomyelitis, and essential ossifying periostitis. Examples of the latter are cases due to mycosis, tuberculosis, syphilis, and leprosy. The "ossifying periostoses" may be due to benign or malignant tumors, lymphoma, trauma, hemorrhagic diseases, trophic and circulatory disorders, and toxic conditions, including those of occupational origin. In the "periostosis" group are also included several entities of undetermined etiology, such as Caffey-Silverman's infantile cortical hyperostosis, Camurati-Engelmann's osteopathy, Uehlinger's generalized hyperostosis with pachydermia, and certain "dysvitaminoses."

The author emphasizes that the cause of the periosteal reaction in a given case can seldom be determined with accuracy solely from inspection of the roentgenogram: clinical correlation and progress studies are most often necessary for adequate evaluation.

One may disagree with the manner in which some of the entities have been pigeonholed but, taken as a whole, this didactic type of essay illustrates very clearly the present state of knowledge as well as the uncertainties inherent in the subject discussed.

Twenty-five roentgenograms; 1 synoptic table.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Endostoses and Periostoses in Leprosy. Luigi Oliva and Guido Farris. Radiol. med., Milan **43**: 1174–1195, December 1957. (In Italian) (L. O., Istituto di Radiologia dell'Università di Genova, Italy)

The skeletal lesions in leprosy have been classified as (*a*) specific osteopathies, either productive (periostitis, osteomyelitis) or osteoporotic (round areas of bone resorption); (*b*) osteopathies due to neurotrophic disturbances (bone atrophy with fractures, or even with spontaneous amputations); (*c*) arthropathies, which may be specific, nonspecific, or trophoneurotic. Few authors mention the presence of endostotic and periostotic lesions.

The authors' series, comprising 54 patients examined between 1953 and 1956, revealed a marked frequency of endostoses and periostoses (various types of periosteal proliferation) in the lower leg (69 per cent) and forearm (59 per cent), the fibula and ulna being most frequently affected. The roentgen appearance was usually that of "productive periostosis" with osteophytes and cortical thickening. The incidence of skeletal involvement increased proportionally with the chronological progress of the leprosy.

This material failed to show any relationship between type of bone lesions and form of leprosy; in fact, endostoses and periostoses seemed to be more frequent in "nervous" leprosy. Clinical study showed a significant association with cutaneous and subcutaneous lesions resembling those caused by venous stasis (varicose ulcers). The belief is expressed, therefore, that these periosteal changes are not the direct result of the infection but an indirect consequence, by way of neurotrophic and circulatory disturbances.

An ample bibliography is appended.

Eighteen roentgenograms, two tables.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Studies in Sickle-Cell Anemia. XI. Bone Involvement Simulating Aseptic Necrosis. Henry T. Carrington, Angella D. Ferguson, and Roland B. Scott. J. Dis. Child. **95**: 157–163, February 1958. (Howard University College of Medicine, Washington 1, D. C.)

This report presents 2 cases of aseptic necrosis of the femur in children with sickle-cell anemia. One of the patients also showed aseptic necrosis of the head of the humerus. The roentgen findings in both cases were typical of aseptic necrosis, with spotty demineralization of the epiphyses and irregularity. In one patient flattening and enlargement of the epiphyses occurred as well.

This osseous lesion probably follows thrombosis of the blood vessels supplying the affected area. Involvement of the femoral neck and head may produce a pathologic picture indistinguishable from classical Legg-Perthes disease. Therapy is based mainly on orthopedic care. The prognosis varies with the extent and site of the lesion. Weight-bearing tends to increase the severity of the disease.

THEODORE E. KEATS, M.D.
University of Missouri

Two Benign Bone Tumors with Rare Localization and Spontaneous Fracture. H. E. Schlitter. Fortschr. a. d. Geb. d. Röntgenstrahlen **88**: 195–200, February 1958. (In German) (Städtische Krankenhaus Moabit, Berlin, Germany)

The author reports 2 cases of spontaneous fractures

in boys of twelve and seven years. In the first case cystic bone changes were noted at the fracture site in the midshaft of the right humerus. Tissue study from curetted material revealed an ossifying fibroma. There was satisfactory healing, with dense periosteal callus developing within a period of four weeks. The usual sites of ossifying fibroma are the cranial vault and jaw bones. According to Jaffe and Lichtenstein, the tumor is a monostotic monotopic form of fibrous osteodysplasia.

The second patient had a spontaneous fracture of the right clavicular midshaft with expansile cystic changes at the fracture site. Curettage was done, and the histologic diagnosis was enchondroma. In connection with this case the ontogenesis of the clavicle and the pathogenetic factors are discussed.

Both cases are considered unusual as to localization and histologic features of the tumors. Impressive illustrations of tissue sections lend special interest to this article.

Three roentgenograms; 5 photomicrographs.

ERNEST KRAFT, M.D.
Northport, N. Y.

Ankylosing Spondylitis. M. L. Aggarwal. Indian J. Radiol. **12:** 7–26, February 1958. (V. J. Hospital, Amritsar, India)

This paper is a general one dealing with the clinical and radiological manifestations of ankylosing spondylitis. The author presents data from 55 cases personally seen. Ninety-five per cent of the patients were males, with onset of the disease in the fifteen-to-thirty-year age period. The bulk of the paper is clinical, but some points helpful to radiologists are made.

The earliest evidence of spinal involvement is usually demonstrable in the posterior spinal joints, even though the earliest *symptoms* may be in the sacroiliac joints. Involved joints do not, as a rule, show narrowing of the joint space because the articular cartilage tends to remain intact and is not destroyed by the inflammatory granulation tissue. As the disease begins to heal, metaplasia of this inflammatory tissue into bone and cartilage occurs, either directly or by endochondral ossification. This results in smooth, bony ankylosis of the joint. The author notes that the incidence of bony ankylosis in the sacroiliac joints is high when the disease appears before the age of twenty and is much less frequent with increasing age at onset.

The sclerosis frequently seen deep to the eroded joint surfaces is a bony condensation thought to be indicative of an active reactive process, and hence a sign of disease activity. Granular calcifications, sometimes seen within ankylosed joints, are explained on the basis that provisional calcification at the time of endochondral bone formation secondary to the disease is not followed by ossification.

Syndesmophytes are small, vertically oriented, sometimes fluffy calcifications occurring in the longitudinal ligaments at the level of the disk spaces without actual spurring of the plateaus of the vertebral bodies. Progression of these lesions to touch the vertebral bodies results in the well known "bamboo" spine. They are characteristic of ankylosing spondylitis but may occur in other diseases also. In the presence of syndesmophytes, the intervertebral disk spaces tend to remain normal in contradistinction to the frequent loss of disk spacing with hypertrophic spurrings. When peripheral joints are involved, there is usually joint space reduction.

The author does not believe that ankylosing spondylitis is the same disease as rheumatoid arthritis of the spine. Some differential radiographic points concern the presence of bone sclerosis deep to the involved joints in ankylosing spondylitis, a finding not present in rheumatoid arthritis. Also, in the latter disease, when bony ankylosis occurs the joint space is usually absent, while joint spacing tends to remain near normal in ankylosing spondylitis with bone fusion. There are other clinical and serologic differences in the two diseases. Tuberculosis of bones and joints may mimic ankylosing spondylitis at some sites. Absence of cold abscess and a tendency of inflammatory tissue to be transformed into bone are characteristics of ankylosing spondylitis not seen in tuberculosis.

The multiple radiographic reproductions, though not of good quality in many instances, are helpful in demonstrating the points under discussion.

Twenty-five roentgenograms; 3 photographs; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

A Roentgenographic Study of the Lumbosacral Spine in Children. C. A. Splithoff. Surg., Gynec. & Obst. **106:** 193–195, February 1958. (Children's Hospital of the East Bay, Oakland, Calif.)

One hundred normal children, both white and colored, ranging in age from five to fifteen years, were studied roentgenographically to determine the widths of the lumbosacral disks, the angles of the sacra, and the incidence of lumbosacral structural alterations.

The structural abnormalities found included 13 cases of transitional vertebrae, 4 cases of butterfly vertebrae, 18 cases of spina bifida occulta, and 3 cases of spondyloschisis. No instance of spondylolisthesis was detected. The author presents data to suggest that spondylolisthesis and its associated neural arch defects are probably acquired, since their incidence seems to increase with age.

Presacral disks showed posterior measurements ranging from 0 to 8 mm., with the largest group (28 of 100) measuring 3 mm. The anterior disk measurements ranged from 6 to 15 mm., with 64 of the 100 measuring from 9 to 12 mm., which is approximately the same as in adults.

The angle formed by a line parallel to the superior surface of the sacrum and the horizontal was measured. The average angle for the group was 31.6°, while the same angle in adults has been shown to average 42.5°.

One drawing; 3 graphs; 1 table.

S. DAVID ROCKOFF, M.D.
University of Pennsylvania

Hyperextension Injuries of the Cervical Spine. Eben Alexander, Jr., Courtland H. Davis, Jr., and Charles H. Field. Arch. Neurol. & Psychiat. **79:** 146–150, February 1958. (Bowman Gray School of Medicine, Winston-Salem, N. C.)

The authors discuss the dynamics predisposing to severe injury to the spinal cord in the absence of either fracture or dislocation in hyperextension injuries of the cervical spine. When the sagittal diameter of the spinal canal is 13 mm. or less and may be decreased 2 mm. more in hyperextension than in full flexion, hyperextension injuries are most likely to occur, especially in the presence of degenerative arthritis. Under such circumstances the dorsal surface of the spinal cord is compressed by the ventral surface of the lamina and the

ventral surface of the cord by the bony spurs on the dorsal surface of the vertebral bodies. A representative case of such cervical spinal cord injury is presented.

Recovery from hyperextension injury varies, depending upon the extent of the damage to the spinal cord. The arms, especially the hands, suffer more than the legs.

Treatment consists mainly in rehabilitation aided by physical therapy. Surgical intervention is indicated only if actual continued compression of the spinal cord is demonstrated by plain roentgenogram, myelogram, or manometric block of cerebrospinal fluid on lumbar puncture.

Five roentgenograms. W. J. VARLEY, M.D.
Mercy Hospital, Pittsburgh, Penna.

Electromyography in Herniated Lumbar Disks. Robert A. Mendelsohn and Anders Sola. Arch. Neurol. & Psychiat. **79:** 142–145, February 1958. (R. A. M., 3700 U.S.A.F. Hospital, Lackland A.F.B., San Antonio, Texas)

In order to evaluate electromyography as a practical clinical aid in the localization of herniated lumbar disks, the authors reviewed the records of 45 consecutive patients who had been examined by electromyography and iophendylate (Pantopaque) myelography and had been found at operation to have protruded lumbar disks.

Of these 45 cases, 40 had accurately localizing electromyograms, and 38 had accurately localizing myelograms. None of the 7 cases with incorrectly localizing or normal myelograms had incorrectly localizing or normal electromyograms, while none of the 5 cases with incorrectly localizing or normal electromyograms had incorrectly localizing or normal myelograms. In 38 cases there were objective neurologic deficits.

The authors infer that electromyography is of clinical value in the localization of protruded lumbar disks.

Two tables. J. A. BURWELL, M.D.
Mercy Hospital, Pittsburgh, Penna.

"Idiopathic" Scoliosis of Congenital Origin. A. H-Ros Codorniu. J. Bone & Joint Surg. **40-B:** 94–96, February 1958. (Gran Hospital de la Beneficencia General, Madrid, Spain)

Idiopathic Scoliosis in Identical Twins. Rafael Esteve. J. Bone & Joint Surg. **40-B:** 97–99, February 1958. (Camitas Blancas (Instituto Policlinico) and Hospital de San Juan de Dios, Barcelona, Spain)

The report from Madrid deals with identical twin girls in whom scoliosis developed at the age of ten. The cause of idiopathic scoliosis is not known, but the development, in uniovular twins, of a similar deformity at the same time and of the same degree, with a similar rate of progressive deterioration, suggests that congenital factors may be operative.

Two roentgenograms; 1 photograph; 1 table.

Esteve, of Barcelona, reports another case of spontaneous scoliosis developing in uniovular twin girls, at the age of six. Allowing for minor differences, their deformities were essentially alike in both the primary and secondary curves. From the evidence, the author deduces a congenital defect involving a segment of the spine and not becoming manifest until some time after birth.

Two roentgenograms; 2 photographs.
SAUL SCHEFF, M.D.
Boston, Mass.

Stress Fracture of the First Rib. Nicola Ludovico and Franco Caldera. Radiol. med., Milan **44:** 54–67, January 1958. (In Italian) (Istituto di Radiologia e del Radio della Università di Bologna, Italy)

The authors suggest that the term "duration" fracture be used when bone continuity has been interrupted as the result of a long-standing process. Aside from the external force, an intrinsic, perhaps developmental, structural weakness may be a prerequisite. Furthermore, the opinion is expressed that fractures of the first rib(s), because of the peculiar location, cannot (or very seldom) be the result of trauma alone. Even when a single injury has preceded the supposed moment of actual fracture, it is assumed that there must have pre-existed a "dysembriogenetic" site of minor osseous resistance.

Twenty-one cases of fracture of the first rib(s) are briefly discussed. Only 2 of the 21 patients ever complained of pain.

Fifteen roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Roentgenologic Variations in the Pelvis in Newborn Infants with Mongolism. H. J. Kaufmann and S. Pelargonio. Schweiz. med. Wchnschr. **87:** 1529–1532, Dec. 14, 1957. (In German) (Boston University School of Medicine, Boston, Mass.)

The authors review briefly the clinical findings in newborn infants with mongolism, such as abnormal facies, deformity of the little finger, grooved tongue, and generalized hypotonia. Roentgen changes in the skeleton are hypoplasia of the base of the skull and the facial bones, including the nose, as well as hypoplasia and dysplasia of the carpals and metacarpal bones. In addition, there may occur changes in the pelvis which include a reduced acetabular angle, abnormal size and lateral flaring of the ilium, and an abnormally long ischium. The authors have seen 14 cases with such findings, which confirm the observations of Caffey and Ross (Pediatrics **17:** 642, 1956. Abst. in Radiology **68:** 456, 1957).

The acetabular angles in the series studied ranged from 6 to 27° with only two over 20° (normal 28°). The angle of the ilium was also below normal as was the ilium index (obtained by adding the right and left acetabular angles and the right and left ilium angles and dividing by 2). The authors suggest that the changes in the pelvis may be a constant finding in mongolism and may be a diagnostic aid in clinically doubtful cases in the immediate post-partum period.

Two roentgenograms; 14 tables.
JULIUS HEYDEMANN, M.D.
Chicago, Ill.

The Diagnosis of Dislocation of the Hip in Newborns and the Primary Results of Immediate Treatment. L. Andrén and S. von Rosen. Acta radiol. **49:** 89–95, February 1958. (Malmö General Hospital, Malmö, Sweden)

A new method for roentgen demonstration of congenital dislocation of the hip is presented by the authors. They feel that present methods, based on measurements of various distances and angles in anteroposterior roentgenograms of the pelvis, make the diagnosis difficult—or sometimes impossible—because of the latitude of normal measurements. Their method requires that the femora be kept dislocated during the examination. The legs are abducted to a

least 45°, with internal rotation of the femora. If the hip is normal, a line drawn through the axis of the femoral shaft will cross the upper edge of the acetabulum. In the presence of dislocation, it will cross the anterior superior iliac spine.

Among 15,373 children born in the Malmö General Hospital (Sweden) in five years, 14 cases of congenital dislocation of the hip (13 bilateral) were discovered on routine physical examination.

Treatment consisted of immobilization with the legs abducted and externally rotated. The authors feel that immobilization for a few weeks is probably sufficient. Adequate treatment of cases detected at birth was not followed by roentgenologically demonstrated hypoplasia of the hip.

Six roentgenograms. HOWARD GOULD, M.D.
St. Vincent's Hospital, New York

Congenital Vertical Talus. G. C. Lloyd-Roberts and A. J. Spence. J. Bone & Joint Surg. **40-B:** 33–41, February 1958. (Hospital for Sick Children, Great Ormond St., London, England)

This is a report of 32 instances of congenital vertical talus in 22 patients. The deformity is present at birth, at which time there is noted a prominence in the sole, from which both the heel and the forefoot rise in a gentle curve with the displaced talus at the bottom. The curved outline of the soft tissues of the sole, dorsiflexion of the forefoot, the vertical talus, and a calcaneus pointing into equinus are well shown radiologically at an early age. The foot is flat and rigid. The talus cannot be forcibly elevated. Eversion of the heel and abduction of the forefoot occur after walking has begun. The talus comes to lie in a line with the tibial shaft and narrows at the waist to resemble an hourglass. The posterior calcaneus remains elevated, while the thinning anterior part points downward to maintain the equinus. The luxated navicular carries with it the metatarsals, thus maintaining the dorsiflexion of the anterior foot. In the anteroposterior view the talus lies far to the medial side of the calcaneus.

In older childhood an awkward and clumsy gait obtain. Pain, if it appears at all, is a late manifestation. In only 9 of this group did congenital vertical talus appear as an isolated defect. Ten had an associated arthrogryposis, 2 spina bifida, and 1 neurofibromatosis.

Idiopathic flatfoot is differentiated by the fact that the deformity does not precede weight-bearing, is reducible at least in the early stages, and is worse on standing. Secondary changes in the body of the talus, navicular, and calcaneus do not occur, nor is there dorsiflexion of the forefoot. Navicular-talar luxation is absent and the talus is never vertical. The same picture as in idiopathic flatfoot obtains in paralytic flatfoot due to poliomyelitis, spina bifida, or cerebral palsy. Spurious correction of clubfoot will occasionally result in a more or less vertical talus, but the waist is not narrowed and the history suggests the diagnosis.

Nine roentgenograms; 4 photographs; 2 tables.
SAUL SCHEFF, M.D.
Boston, Mass.

Tuberculosis of the Pubis. Report of Eleven Cases. O. R. Nicholson. J. Bone & Joint Surg. **40-B:** 6–15, February 1958. (Middlemore Hospital, Auckland, S. E. 7, New Zealand)

The author reports 11 cases of tuberculosis of the pubis seen over the course of seventeen years in England and New Zealand. There was a history of injury in 2 of the cases, and the possibility that local injury may play a part in patients with a tuberculous bacteremia is mentioned. The disease is not limited to a specific age group, occurring in both young children and in older adults. Tuberculous lesions elsewhere may be conspicuously absent; they were present in only 4 of the author's cases. Differentiation must be made from nontuberculous infections of the pubis, osteitis pubis, and the rare osteochondritis of adolescence.

Radiographically, unilateral or bilateral erosion of the pubis is constant, accompanied by some rarefaction of the adjacent rami. Unilateral disease appears to begin in the body and spread across the symphysis. Sequestration is frequent, occurring in 6 of the 11 cases.

Treatment consisted of curettage in 9 patients, removal of the entire bone in 1, and grafting of bone in another. The outcome was favorable in all, with no pelvic instability.

Ten roentgenograms. SAUL SCHEFF, M.D.
Boston, Mass.

GYNECOLOGY AND OBSTETRICS

Advanced Abdominal Pregnancy. Its Radiological Diagnosis. J. V. Todes. Brit. J. Radiol. **31:** 28–31, January 1958. (Baragwanath Hospital, Johannesburg, South Africa)

The author discusses the abnormal appearance of advanced abdominal pregnancy as seen on flat films. He cites DeVilliers (South African M. J. **28:** 254, 1954), who found 77 cases of advanced extra-uterine pregnancy published in the English literature, of which 70 were of abdominal pregnancy; in this series a positive diagnosis was made on straight films of the abdomen in only 8 cases, but Mattingly and Menville (Radiology **38:** 35, 1942), reported correct radiological diagnosis in 7 of 16 cases.

The author describes two of his cases in one of which the diagnosis was made by means of hysterosalpingography, a method which was used as early as 1925. He also describes other diagnostic methods, such as cystography either with air or an opaque medium, injection of air into the peritoneal cavity, and aortography, either by direct puncture or by the retrograde femoral route (Fernström: Acta radiol., Suppl. 122, 1955. Abst. in Radiology **66:** 146, 1956). The latter author investigated 59 cases of pregnancy, of which 21 were extra-uterine. Hysterosalpingography is contraindicated if the fetus is alive, because of the possibility of causing abortion should the pregnancy be intra-uterine.

Three roentgenograms. JULIAN O. SALIK, M.D.
Baltimore, Md.

Hysterosalpingography with Ethiodol. Werner Steinberg. Am. J. Obst. & Gynec. **75:** 144–148, January 1958. (Newark Beth Israel Hospital, Newark, N. J.)

In more than 161 hysterosalpingographies, the author found Ethiodol to be a very satisfactory opaque medium for general use in gynecological diagnosis. Most of the procedures were done as part of sterility investigations. Standard technics were used and follow-up films were obtained at twelve or twenty-four hours and, in a few cases, after three or four days if the earlier film was inconclusive.

From this study it appeared that Ethiodol had superior contrast value, permitting the taking of twenty-four-hour films. No notable degree of pain was associated with its use and there was no intravasation of the medium or exacerbation of chronic salpingitis with its use. The material was absorbed from the peritoneal cavity in about sixty days.

Two roentgenograms; 1 table.

ROBERT L. EGAN, M.D.
University of Texas, Houston

Gaseous Pelvigraphy. Its Use in the Evaluation of Endopelvic Extension of Cervical Cancer. J. Herbeau, M. Verhaeghe, and A. Lequint. J. de radiol. et d'électrol. **39:** 1–12, January-February 1958. (In French) (Centre Oscar-Lambret, Lille, France)

For demonstration of extension of cervical cancer to other pelvic structures, 1,000 to 1,500 ml. of carbon dioxide or oxygen is injected into the left periumbilical region with the patient in a prone position, head down and with feet angulated upward at about 45°. This allows the gas to surround the pelvic organs.

Four hundred examinations of this type were performed on patients with carcinoma of the cervix. About 40 of the group were operated upon and the surgical findings could be correlated with the roentgen findings.

Parametrial extensions on both sides of the uterus and in the regions between the uterus and the bladder anteriorly or the rectum posteriorly could be demonstrated. Occasionally masses of lymph nodes could be shown.

Fourteen roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Notes on Segmentary Intraparietal Uterine Phlebography. P. Feletig and A. Tetti. Radiol. med., Milan **43:** 1196–1203, December 1957. (In Italian) (P. F., Clinica Ostetrico-Ginecologica dell'Università di Torino, Italy)

In 1950, Baux (Toulouse, France) originated a method of pelvic phlebography which consists of injecting 20 c.c. of a 70 per cent organic iodinated compound into the uterine fundal myometrium through a 15-cm. needle inserted through the artificially dilated os. This requires stretching of the uterus, and, in the absence of iodine sensitivity, the only significant contraindication is a fixed uterus (in either ante- or retroflexion). There are two relatively frequent complications, the first being penetration of the uterine wall, with instillation of the iodinated compound into the peritoneal cavity. The second is failure to enter the myometrium, with a consequent (incomplete) hysterogram. Neither is much more than a simple inconvenience.

The authors have adopted the technic of Baux and report encouraging results in this preliminary communication. Roentgenograms exposed immediately after completion of the injection permit excellent visualization of the venous network of the uterus and ovaries. The conditions illustrated in the paper include pelvic varicocele, bicornuate uterus, uterovaginal prolapse, and pelvic fibroma. The authors believe that other indications might be tumors of the pelvis, both prior to and after surgery, pelvic thromboses, and even pelvic inflammatory disease. The method is most helpful when the findings are evaluated within the framework of all clinical and laboratory tests, and also by comparison with more conventional roentgenographic procedures, such as excretory and retrograde pyelography and hysterosalpingography.

Seven roentgenograms; 3 drawings.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

THE GENITOURINARY SYSTEM

Diagnostic Criteria for the Evaluation of Renal Calcifications on Routine Roentgenograms. A. Pacciardi and P. L. Michelassi. Ann. radiol. diag. **31:** 30–55, 1958. (In Italian) (Istituto di Radiologia dell'Università di Pisa, Italy)

The shape, size, and location of calcium deposits in and about the kidneys, as seen on conventional roentgenograms of the abdomen, though they only rarely allow an immediate diagnostic interpretation, are yet sufficiently indicative to point out the need for further investigation and to restrict the number of possibilities.

Perirenal calcifications are rare and usually quite difficult to differentiate among themselves. In perinephritis the deposits are irregular; in hematoma they are more rounded. They resemble vessel walls when the artery is involved. Calcification of a pararenal cyst gives the appearance of a thin wall.

Parenchymal calcification may be either unilateral or bilateral. Solitary unilateral calcifications are classified as pseudocalculous (tuberculosis, trauma, abscess, vascular calcification), cystic (echinococcosis, hemorrhagic, pyelogenic, and dermoid cysts), and polymorphous (tuberculosis, tumors, pyonephrosis, abscess, vascular calcification, trauma). Multiple unilateral calcification may be due to developmental variations, tumors, pyonephrosis, tuberculosis, or polycystic kidneys. Bilateral calcifications are *spheroid* (due to hyperparathyroidism, Albright's disease, sarcoidosis, tuberculosis, nephritis, myeloma) or *polymorphous* (tuberculosis, secondary hyperparathyroidism, and polycystic kidneys).

Calcifications may also be encountered (rarely) in a large number of other conditions, such as brucellosis, Paget's disease, osteopetrosis, hemoglobinuria, extrarenal benign tumors, etc. Five illustrative case reports are briefly given, to emphasize that in any particular instance final diagnosis is best reached by correlation of all the findings.

Seven roentgenograms; one drawing.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Abdominal Crises with Urologic Implications. Stanford W. Mulholland. J.A.M.A. **166:** 455–461, Feb. 1, 1958. (2201 Benjamin Franklin Pkwy., Philadelphia 30, Penna.)

Clinical, radiologic, and therapeutic features of infarction of the kidney comprise the substance of this paper despite its title. Infarctions of the kidney are of three major types: arterial embolism, venous or hemorrhagic infarction, and traumatic infarction. A careful general clinical work-up with special attention to urologic examination and well chosen radiographic procedures will allow a definitive diagnosis in a high percentage of cases.

Arterial infarction is apparently much more common and less lethal than generally believed. It can be diagnosed with accuracy and seldom, if ever, requires

surgical intervention. It is almost always associated with disease of the heart or blood vessels, and a high percentage of afflicted individuals give a history of previous myocardial infarction. Diagnostic features include sudden flank or anterior abdominal pain, nonfunctioning of the involved kidney as shown by intravenous urography, normal renal architecture demonstrable by retrograde urography, and interference with the blood supply of the kidney revealed by renal arteriography. Transient or irreversible hypertension may develop, depending on the size and recovering ability of the infarction.

Hemorrhagic infarction is associated with septic conditions and may occur in infants. The kidney is characteristically greatly enlarged and tender. Gross hematuria is common. Retrograde pyelography ordinarily shows deformity and incomplete filling of the calyces. Intravenous urographic studies demonstrate impaired function. The condition carries a grave prognosis, with a progressive septic course. Occasionally early nephrectomy is helpful.

Traumatic infarction is the result of temporary cessation of renal blood flow and is characterized by pain in the flank, shock, a mass with localized tenderness, hematuria, absence of renal function as demonstrated by intravenous urography, and a tendency toward normal calyces as shown by retrograde studies. General findings are similar to those well known in traumatic rupture of the kidney. A less well understood condition called "post-traumatic ischemic infarction," due to arterial spasm, is commented upon.

Case histories of 7 patients are given in moderate detail. Five renal arteriograms are helpful in demonstrating the points under discussion.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Neuroblastoma in Orthopaedic Practice. P. I. Busfield. J. Bone & Joint Surg. **40-B:** 47–57, February 1958. (Postgraduate Medical School, London, England)

In a series of 106 cases available for analysis the presenting symptoms of neuroblastoma were such that the patient might have been referred to an orthopedic surgeon in 24 instances (22.5 per cent). The complaints included pain about a joint, usually in the lower extremity; an unexplained limp or disinclination to walk; acute pain in a bone with signs resembling acute osteomyelitis; backache; the development of paraplegia. Clinically the most important finding is the palpation of a mass in the abdomen, which may represent the adrenal tumor, a displaced kidney, or a liver enlarged by metastatic involvement.

A plain film of the abdomen may reveal a mass of soft-tissue density due to the tumor or to displaced kidney. Calcification is common, ranging from fine speckling to a dense opacity in the adrenal area. The diaphragm may be elevated. The most important single study is contrast urography, which usually shows downward and lateral displacement of the renal pelvis. Ureteric obstruction and hydronephrosis are less common.

When the tumor is primary in the thoracic chain of sympathetics, an hour-glass tumor in the posterior mediastinum with or without destruction of the neighboring vertebra and ribs may be seen. Metastases may be manifest as nodules in the lungs or as destructive processes in the ribs. Secondary deposits in the long bones are usually osteolytic; they may be bilateral and symmetrically placed near the metaphyses, accompanied by laminated, onion-skin layers of subperiosteal new bone formation. Pathological fracture is not rare. The skull may be mottled by lytic lesions from which perpendicular new bone may be laid down to produce "sun-ray" spiculation. Intracranial extension will widen the sutures in younger children.

Six cases with orthopedic symptoms are reported. Early diagnosis in these and other such cases rests on a high degree of suspicion to enable one to direct the proper studies. The treatment is surgery, ionizing radiation, or both. The author adds vitamin B_{12}.

Four roentgenograms; 2 photographs; 1 photomicrograph.

SAUL SCHEFF, M.D.
Boston, Mass.

Cinefluorography for the Urologist. Henry Bodner, Allan H. Howard, and Joseph H. Kaplan. J. Urol. **79:** 356–362, February 1958. (6333 Wilshire Blvd., Los Angeles 48, Calif.)

This article is designed to acquaint the urologist with the present technics of cinefluorography, to predict possible future developments, and to indicate applications to urologic practice.

The authors present a short history of the development of cineradiography and cinefluorography. They trace the search for more efficient intensifier screens, terminating with the present electronic screen intensifiers. These electronic screen intensifiers make possible adequate cinefluorographic examinations without exposure of patient or operator to excessive radiation. Further reduction in the amount of radiation received by the patient is achieved by synchronizing the x-ray impulses with the camera shutter. A time clock or stop watch is necessary to keep the duration of the examination within the recommended time of three to six minutes.

The authors are hopeful that future developments in equipment will result in larger field coverage with the electronic intensifier, an increase in the brightness of the phosphor layer over that of the present screen, and possibly development of a television type detector tube directly sensitive to x-rays. They foresee the use of stereocinefluorography and a biplane type of apparatus. In this latter application, however, they are concerned with the radiation hazard.

It is predicted that cinefluorography will be the usual method of urography in the future. They consider it the most efficient method for pyelographic examination available today. They have used the technic with intravenous and retrograde pyelography to study the dynamics of ureteral peristalsis. Finally, they feel it not unreasonable to predict the use of image amplification in conjunction with closed circuit television for visual instrumentation of the urinary tract.

ROBERT JACOBS, M.D.
University of Pennsylvania

Pelvic Phlebography in Urogenital Disease. Aguinaldo Lins. Rev. de urol., Recife **2:** 85–88, November 1957. (In Portuguese) (Instituto de Radiologia da Faculdade de Medicina da Universidade do Recife, Brasil)

Visualization of pelvic veins may be achieved by injecting contrast medium into the deep dorsal vein of the penis, into the corpora cavernosa (in females into the clitoris), or into the osseous girdle of the pelvis. The

procedure is of value especially in the study of periprostatic, perivesical, and deep pelvic veins.

In patients with prostatic carcinoma there is a notable frequency of thromboses and of other vascular obstructions. In prostatic hypertrophy one may find topographic alterations of Santorini's plexus and, notably, an increase in the vascular bed. This is often so pronounced that the author uses pelvic phlebography as a routine procedure, prior to excretory urography, in the evaluation of prostatic cases.

Three roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

MISCELLANEOUS

Differential Diagnosis of Retroperitoneal Tumors. A. Gebauer and J. Lissner. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 200–210, February 1958. (In German) (Ludwig-Rehn-Str. 14, Frankfurt a. Main, Germany)

Retroperitoneal tumors most frequently arise from the kidneys and adrenal glands (pancreatic tumors being excluded in this article). In a second group, including lipoma, fibrosarcoma, and retroperitoneal cysts, the neoplasms have no connection with a specific organ. These primary retroperitoneal tumors have to be differentiated from manifestations of a systemic disorder such as reticulum-cell sarcoma and chronic lymphadenosis.

For diagnostic purposes retropneumoperitoneum, perirenal air insufflation, and pyelography, either separately or in combination, are most revealing. At times tomography may be necessary for additional information.

Tumors of the adrenal gland can be differentiated from hypernephroma at the upper pole of a kidney with the aid of pyelograms. Two representative cases are illustrated. In the first patient, with an adrenal tumor, the pyelogram was normal. In the second case, with a mass in the same location, a hypernephroma could be recognized pyelographically.

Primary retroperitoneal tumors produce displacement of a kidney, kidney pelvis, or ureter without distortion of kidney contour. Displacement of gastrointestinal organs is evident only when the tumor is rather large. Calcifications are rare, having been seen only in neuroblastoma and retroperitoneal osteogenic sarcoma. In lipoma increased radiolucency of the soft-tissue mass is frequently observed.

Malignant retroperitoneal tumors are found more frequently than the benign types. Lipoma usually is larger than any other tumor and has a tendency to recur and to become sarcomatous. Two cases of primary retroperitoneal tumor are illustrated: a fibrosarcoma and a large lipoma.

Tumor manifestations of a systemic disorder are found more frequently than primary retroperitoneal tumors. Because of the relatively small size of these masses, tomography and other diagnostic aids may become necessary for proper localization. The most important clue in borderline cases usually is minimal displacement of a ureter. Two representative cases are described: a reticulum-cell sarcoma and a chronic lymphadenosis.

Splenomegaly may cause the same organ displacement as primary retroperitoneal tumors and has to be excluded in the differential diagnosis of left upper-quadrant masses. A case is briefly reported in which what was believed to be a retroperitoneal tumor proved on operation to be a cyst arising from the upper pole of the spleen posteriorly.

Thirteen roentgenograms; 1 photograph; 3 drawings. ERNEST KRAFT, M.D.
Northport, N. Y.

Roentgenographic Features of Neurenteric Cysts. E. B. D. Neuhauser, G. B. C. Harris, and A. Berrett. Am. J. Roentgenol. **79:** 235–240, February 1958. (E. B. D. N., Children's Medical Center, 300 Longwood Avenue, Boston 15, Mass.)

A neurenteric cyst is a cystic structure having a wall histologically resembling some segment or segments of the foregut which may have connections by means of a stalk to the meninges and spinal cord through a tunnel-like defect in the vertebral bodies. In the early human embryo, a canal develops in relation to the formation of the notochord. This canal passes from the yolk sac through the primitive knot to the amniotic cavity. Hence there is a communication from the gut, passing through the midline dorsal structures to the dorsal surface of the embryo. This is a normal but very transient structure, although remnants of this canal may persist. Similar, but evidently accessory, canals may form and the unobliterated remnants may give rise to anomalies of clinical significance. The authors present four cases of neurenteric cysts as examples of such a malformation.

Roentgenologically, the lesion is characterized by a defect in the anterior aspect of the spine associated with faulty formation of the vertebrae and a mediastinal soft-tissue mass. The mass may be continuous with a giant diverticulum or duplication of the intestinal tract and associated with a diaphragmatic hernia. The spinal anomaly is usually that of cleft vertebrae and widening of the neural canal. An actual tunnel through the vertebral body is sometimes present but not invariably so. The authors suggest that diastematomyelia, midline dermoids, and other anomalies represent different manifestations of this aberration of fetal development.

Eleven roentgenograms.
CAPT. BYRON G. BROGDON, M.C.
Parks AFB, Calif.

Inguino-Ilio-Pelvic Lymph Node Invasion Demonstrated by Lymphography. J. M. Collette. Acta radiol. **49:** 154–165, February 1958. (In French) (Centre Anticancéreux, Université de Liège, Belgium)

The author utilized direct lymphography by injection of a tri-iodized water-soluble contrast material through a cannula into a peripheral lymphatic trunk in a lower limb visualized by the previous injection of a dye.

The normal lymphadenogram as well as the abnormal one with neoplastic invasion is described. The method allows the confirmation of the clinical diagnosis of lymph node involvement and the determination of its extent; confirmation (or rejection) of clinically doubtful cases; and finally the detection of metastases in those cases not suspected clinically.

While lymphography is suitable for a variety of pelvic cancers, Hodgkin's disease, cancer of the rectum, bladder, and prostate, the results are most spectacular in carcinoma of the cervix.

Sixteen roentgenograms; 3 tables.
CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Pleas of Internists to Radiologists. E. Hafter and A. Wernli-Hässig. Schweiz. med. Wchnschr. **88:** 13–16, Jan. 4, 1958. (In German) (E. H., Tödistrasse 36, Zurich, Switzerland)

Two internists give their views on difficulties resulting from separation of internal medicine and radiology. The most frequent misunderstandings are said to arise as a result of insufficient contact between clinicians and radiologists.

The authors make several suggestions for examinations of the gastrointestinal tract, both as to technic and interpretation. Examinations should be made in the upright as well as in the prone or supine position. The esophagus should not be reported as normal unless it has been demonstrated in its entire length. For esophageal examination, a 1 per cent solution of carboxymethylcellulose and barium is recommended. Mucosal films of the stomach are not entirely sufficient unless supplemented by films with the stomach completely filled. Duodenal ulcer should be sufficiently well demonstrated that arrows pointing to a questionable area are not necessary. Diagnoses of gastritis, enteritis, and colitis are too often made on questionable criteria. Oral cholangiography should not be neglected in favor of intravenous cholangiography.

In pulmonary diseases, the x-ray findings should be correlated with the clinical observations and questionable infiltrates should not be diagnosed with certainty without knowledge of the clinical factors. The x-ray reports should be short and not contain descriptions of normal observations. The interpretations should first be strictly radiological; only later should the clinical picture be considered as it may influence the diagnosis.

The authors also suggest that the clinician pose a clear and concise question to the radiologist which will help him to arrive at a proper diagnosis. Only close collaboration between internists and radiologists will give optimum results. JULIUS HEYDEMANN, M.D.
Chicago, Ill.

TECHNIC

Thick-Layer Tomography. I. Experimental Research. II. Practical Applications. Pier Luigi Cova and Giuseppe Pompili. Radiol. med., Milan **43:** 1057–1081, November; 1153–1173, December 1957. (In Italian) (Istituto di Radiologia dell'Università di Milano, Italy)

The thickness of the layer in body section roentgenography is determined by the angular excursion (measured in degrees) of the tube, patient, and/or film during the exposure. A virtual thickness of 1 mm. requires a pendular motion of 50°; for 2 mm. the figure is 30°, for 3.5 mm. 20°, and for 5 mm. 10°. Thin layers are a prerequisite in the investigation of the mediastinum, the larynx, the middle and the internal ear, and in these cases 30–50° of angulation are necessary. Conversely, a 10° excursion, which is simpler to achieve, can provide adequate results in the study of the skeletal system.

Twenty-three figures. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Scintillation Camera. Hal O. Anger. Rev. Scient. Instr. **29:** 27–33, January 1958.

A new and more sensitive gamma-ray camera for visualizing sources of radioactivity is described. It consists of a lead shield with a pinhole aperture, a scintillating crystal within the shield viewed by a bank of seven photomultiplier tubes, a signal matrix circuit, a pulse-height selector, and a cathode-ray oscilloscope. Scintillations that fall in a certain range of brightness, such as the photopeak scintillations from a gamma-ray-emitting isotope, are reproduced as point flashes of light on the cathode-ray tube screen in approximately the same relative positions as the original scintillations in the crystal. A time exposure of the screen is taken with an oscilloscope camera, during which time a gamma-ray image of the subject is formed from the flashes that occur. AUTHOR'S ABSTRACT

RADIOTHERAPY

Treatment of Cancer of the Tongue at Hartford Hospital, 1931–1952. N. William Wawro and Albert Babcock. New England J. Med. **258:** 317–322, Feb. 13, 1958. (N. W. W., Hartford Hospital, Hartford, Conn.)

One hundred and twenty-eight patients with cancer of the tongue were treated in the Hartford (Conn.) Hospital in a twenty-one-year period. Advanced lesions were common, and there was an average delay of six months from onset of symptoms to institution of therapy. The authors plead for more vigorous effort at early diagnosis and emphasize the value of biopsy regardless of serology and without waiting for a therapeutic trial with antibiotics.

The patients in this series were treated with radiation, surgery, or a combined approach. There was no single continuous plan of therapy. There appears to have been a tendency to utilize radiation more often in the first decade of this series, with more aggressive surgical treatment in the second half of the survey. The absolute five-year survival rate was 22 per cent. Survival statistics for the second half of the report period were slightly improved.

The following program of therapy for cancer of the tongue is suggested:

(1) Hemiglossectomy or radiation for lesions confined to the anterior half of the tongue without significant lymphadenopathy.

(2) Radical monoblock resection of the tongue, floor of the mouth, mandible and cervical lymph nodes for lesions involving the anterior half of the tongue with associated ipsilateral cervical lymph node enlargement.

(3) Combined external beam therapy with supplementary interstitial radium for neoplasms of the posterior half of the tongue.

(4) Prophylactic neck dissections are not recommended. CAPT. NEIL E. CROW, M.C.
Parks AFB, Calif.

The Use of L-Triiodothyronine as a Pituitary Depressant in the Management of Thyroid Cancer. Colin G. Thomas, Jr. Surg., Gynec. & Obst. **106:** 137–144, February 1958. (North Carolina Memorial Hospital, Chapel Hill, N. C.)

Studies done on euthyroid and hyperthyroid patients

and on patients with thyroid cancer showed 1-triiodothyronine to be an effective depressant of the pituitary output of thyrotropic hormone. This was demonstrated by histologic evidence of atrophy of the thyroid gland and depression of radioiodine uptake. In addition, this drug has the advantage over thyroid extract in that the level of serum protein-bound iodine can still be followed as an indication of the output of endogenous thyroid, since 1-triiodothyronine binds only loosely to serum protein. Suppression of the pituitary with doses varying from 50 to 300 micrograms results in a fall in the serum P.B.I. to myxedematous levels similar to those seen following hypophysectomy.

Studies of P^{32} incorporation into the gland as an indication of metabolic activity show that this activity is suppressed by 1-triiodothyronine, but more so in normal tissue than in malignant tissue. Apparently the factors controlling growth and function of the thyroid are independent and, while the control of function by thyrotropic hormone is affected by pituitary depression, growth may be less affected. Probably all tumors bearing histologic similarity to normal thyroid will prove to have some degree of dependency on thyrotropic hormone.

Ten cases of thyroid carcinoma treated with 1-triiodothyronine are tabulated. Dramatic reduction in the size of pulmonary and bony metastases was demonstrated in 1 patient and apparent benefits in several others. The response seems similar to that observed when other means of pituitary inhibition are employed.

Four roentgenograms; 3 photomicrographs; 1 diagram; 3 graphs; 2 tables.

LESLIE M. ZATZ, M.D.
University of Pennsylvania

Statistical Study and Critical Observations on 105 Cases of Mammary Carcinoma Treated Exclusively with Roentgen Therapy. Giulio Bortolotti and Pietro Gugliantini. Radiol. med., Milan **43:** 770–789, August 1957. (In Italian) (Policlinico Umberto I, Rome, Italy)

After a theoretical introduction and brief review of recent literature on mammary cancer, the authors describe the method used by Prof. Nuvoli (Rome). After elimination of about 50 patients who could not be traced, their series numbered 105. In only 40 per cent of these were biopsies done, chiefly elsewhere, because, in the department from which this report comes, histologic examination is requested only when there are doubts regarding the clinical diagnosis. Even the minor surgical trauma inflicted at the time when the specimen is obtained may result in the spread of tumor cells. The clinical diagnosis, however, was believed to be beyond reasonable doubt in all cases.

Roentgen therapy was the only treatment received by the 105 patients discussed. A single 15×20-cm. port over the breast (lengthwise so as to include the anterior axillary fold) was irradiated at 200 to 220 kvp, 8 to 12 ma, 1 mm. Cu plus 2 mm. Al filtration, at a focal distance of 50 to 60 cm., the total dose being 3,400 r in "fractionated" daily doses of 200 r each. When there was clinical evidence of axillary and/or supraclavicular lymph node involvement, additional 8×10 or 10×15 fields were irradiated over the particular location(s) involved. The total dose of 3,400 r was established by Nuvoli on the basis of a long clinical experience. The intention is to start an involutive process in the irradiated tumor without damaging the surrounding healthy tissues, the latter being needed to replace the "decaying" neoplastic tissue. The assertion is made that, in this manner, complete healing can be achieved to the point where actual restoration will make it impossible to recognize that there ever was a tumor in the breast under consideration.

Of the 105 patients (all treated between 1942 and 1952), 59 were followed five years or longer. Of those seen initially in Stage I (Steinthal), 80 per cent (8 of 10 patients) had survived five years. In Stage II the survival rate was only 56.8 per cent (21 of 37), and in Stage III 8.4 per cent (1 of 12). A reshuffling of the figures showed that Stages I and II allowed a total of 83 per cent three-year cures (sic!) or 66 per cent five-year "cures" in the 47 cases which were followed beyond that time-span.

Six tables.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

The Comparison of Two Radiotherapy Techniques in Breast Carcinoma. R. W. Gunderson. Proc. Roy. Soc. Med. **51:** 120–122, February 1958. (Portsmouth, England)

The results in two groups of postoperative carcinoma of the breast patients, managed by two different radiotherapeutic technics, are compared. The "short-course" group comprised 162 patients. Tumor doses of 2,000 to 4,000 r were delivered in two to four weeks to the chest wall, axilla, and supraclavicular area of the involved side. The "long-course" group was composed of 158 patients who received a mean tumor dose of approximately 5,500 r over a period of eight to ten weeks. The internal mammary chain of nodes was included in the radiation field, in addition to the chest wall, axilla, and supraclavicular area. No details of the technics are given. All patients were followed five or more years.

The Manchester staging system, which is quite similar to the clinical staging of Haagensen and Stout, was used. Each group is subdivided into stages, and percentages of five-year cures and recurrences are tabulated. Results for the "short-course" group are about the same as those published by others. Patients receiving the "long course" showed somewhat better results than average for the earlier stages, and definitely superior results for the more advanced stages.

It is pointed out that the most precise measurement of the effectiveness of radiotherapy is the *local* recurrence rate, and that such recurrence was definitely diminished by the high-dose, long-term technic. The long-course technic also shows superior results for the more advanced stages of the disease in terms of longevity and decreased generalized metastases.

Three tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Castration in Breast Cancer. Lothar Diethelm. Strahlentherapie **104:** 524–531, December 1957. (In German) (Röntgenabteilung der Chirurgischen Universitätsklinik Kiel, Germany).

The hormonal influence on an existing carcinoma can be best observed when the production of hormones is considerably increased, as during pregnancy. It is well known that pregnancy has an unfavorable influence on the prognosis in breast cancer, decreasing the five-year cure rate.

The favorable results obtained by the use of female hormones and by castration in prostatic cancer revived

interest in castration in breast cancer. A number of radiologists routinely advise this procedure in patients who have not reached the menopause.

Castration aims at three goals: (1) improvement of the therapeutic effect; (2) prevention of conception; (3) action on ovarian metastases or their prevention.

The value of castration in breast cancer can be best judged in the operable Stage II (Steinthal-Anschuetz), the actual test stage. An analysis of 47 cases dating back more than five years and of 81 cases dating back more than two years, leads to the impression of an improved cure rate. The author suggests that definite statistical confirmation can be obtained only by a uniform work-up on a greater number of patients at different places.

Two graphs; 4 tables. HERBERT POLLACK, M.D.
Chicago, Ill.

Local Chemotherapy of Pleural Carcinosis and Its Combination with Roentgen Irradiation. S. Piller. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 76–83, January 1958. (In German) (Lossburger Strasse 26, Freudenstadt, Germany)

Thirteen cases of pleural carcinosis were treated by repeated instillations of a solution of trimethylolmelamine (CN) at body temperature after removal of most of the exudate. Sodium sulfite solution was added to prevent formation of formaldehyde, with consequent pleural pain. In 9 of the 13 cases tangential x-irradiation to the pleura was given in addition. This was considered indicated if, after about 10 thoracic punctures and CN instillations, the pleural effusion recurred and/or the exudate remained positive for tumor cells. Intrapleural chemotherapy is considered useless if the chest film reveals extensive pleural metastasis with large tumor masses.

In contrast to metastatic pleural carcinosis, extension of a pulmonary neoplasm to the pleura requires therapy to the primary tumor. The course of the pleural extension depends entirely on the course of the primary lesion in the lung.

Eight roentgenograms. G. A. DOEHNER, M.D.
St. Vincent's Hospital, New York

Vaginal Metastases from Adenocarcinoma of the Corpus Uteri. Felix N. Rutledge, So Khim Tan, and Gilbert H. Fletcher. Am. J. Obst. & Gynec. **75:** 167–173, January 1958. (University of Texas M. D. Anderson Hospital and Tumor Institute, Houston, Texas)

Vaginal metastases from adenocarcinoma of the corpus uteri are of sufficiently high incidence to cause concern and to justify prophylactic irradiation. In 1,017 cases of carcinoma of the endometrium collected from the American literature, metastatic disease to the vagina was recorded in 10 per cent.

Of 245 cases of adenocarcinoma of the corpus uteri seen in the University of Texas M. D. Anderson Hospital and Tumor Institute from 1944 to July 1956, 35 showed disease in the vagina. Vaginal metastases were present in 15 cases when the patients were first seen, without prior treatment of the primary tumor. Hysterectomy had been done in 18. The remaining 2 were from a group of 139 who had received prophylactic radium therapy. Forty-two of this latter number had a follow-up of at least four years. Because of the fact that the majority of vaginal metastases appear within one year, the 1.5 per cent incidence of metastatic disease in this group, as compared to figures reported by others, seems to point to the effectiveness of prophylactic radium therapy to the uterus and vagina.

Until 1952 Manchester type ovoids and a vaginal cylinder were used. Since that time the Bloedorn applicator has been employed. This consists of plastic ovoids and a vaginal cylinder that can be assembled as a unit with individualized combination of ovoids of proper size and a vaginal cylinder of appropriate dimensions. Because of the large amount of radium in this type of applicator, it is inserted separately a week after the first packing and is usually allowed to remain four days to deliver 7,000 gamma r to the entire vaginal mucosa.

Two figures; 6 tables. ROBERT L. EGAN, M.D.
University of Texas, Houston

Late Results of Radiation Therapy for Cancer of the Cervical Stump. Robert E. Fricke and David G. Decker. Am. J. Roentgenol. **79:** 32–35, January 1958. (Mayo Clinic, Rochester, Minn.)

Carcinoma of the cervical stump is divided into two classes: (1) the "coincident case" in which the disease develops less than two years following subtotal hysterectomy, and (2) the "true case" with disease appearing at least two years after hysterectomy.

An earlier report on cancer of the cervical stump from the Mayo Clinic concerned itself with patients treated between 1915 and 1930 (Fricke and Bowing: Am. J. Roentgenol. **43:** 544, 1940). At that time five-year survivals among the true cases amounted to 26.3 per cent of the total, and five-year survivals among the coincident cases amounted to 21.4 per cent. The present report is concerned with similar lesions treated from 1940 through 1949.

Eighty-seven cases were adequately traced for this study. Among the 74 true cases there were 50 five-year survivals (67.6 per cent), for an absolute survival rate of 61 per cent. For the 13 coincident cases, the five-year survivals amounted to 4 (30.8 per cent). For the total cases traced, the five-year survival rate was 62 per cent (absolute rate 57 per cent).

The main attack on the disease has been the use of radium in the cervical stump as well as in the vagina. The intensive broken-dose method was used, with four applications to the cervical canal and two or three applications to the vagina. Treatments were given two or three times each week. The total radium dosage averaged 4,000 to 4,700 milligram-hours and yielded 4,500 gamma r to point A and 1,150 gamma r to point B. External roentgen therapy augmented the dosage to points A and B.

The improved results shown in this study are apparently due to improvement in preoperative gynecological diagnosis as well as improved surgical technics, resulting in a smaller number of subtotal hysterectomies where there is unsuspected malignant disease. It is also significant that a larger portion of true cases in this report were seen at an earlier stage than in the previous study. RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

A Radium Applicator for Use in the Treatment of Cancer of the Uterine Cervix. James F. Nolan, John H. Anson, and Maida Stewart. Am. J. Roentgenol. **79:** 36–41, January 1958. (J. F. N., 1407 South Hope St., Los Angeles 15, Calif.)

A radium applicator is described which consists of

three integral parts: an endocervical tandem, a contracervical spacer, and a pair of cylinders which are applied to the vaginal fornices. The tandem may be adjusted on the spacer, and the vaginal cylinders can be placed individually. The applicator can, therefore, be introduced easily and with good visibility. It is quite flexible. Ease of handling reduces radiation exposure to the hands of the operator. After introduction, the applicator may be adjusted so that the axes of the vagina and cervix are maintained in their normal anteflexed relationship. Lead is strategically incorporated in the device to shield the bladder and rectum.

The radiation pattern about the applicator was studied with film dosimetry. When the applicator is loaded with unit sources in the cervical and midportions of the tandem and double-unit sources at the tip of the tandem and in the vaginal cylinders, an exposure of 6,000 mg. hours yields theoretically effective dosage at a distance of 4 cm., while the theoretically necrosing dose lies well within 1 cm. of the radiation sources. Radiation dosage from this applicator along the A-B axis compares favorably with measurements of dosage from the Ernst and Manchester applicators.

The applicator has been used in 109 patients with satisfactory results.

Seven figures; 3 tables.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Factors in the Prognosis of Carcinoma of the Kidney. E. W. Riches. J. Urol. **79:** 190–195, February 1958. (Middlesex Hospital, London, England)

There appears to be general agreement on the average survival rate for carcinoma of the kidney after a stated period; namely, 50 per cent three-year survival; 40 per cent five-year survival; and 20 per cent ten-year survival, with a 3 per cent three-year survival in untreated cases.

The author feels there are six factors influencing prognosis: (1) histologic grade of the tumor; (2) involvement of the renal vein by tumor; (3) lymph-node invasion; (4) local extension of the growth; (5) presence of metastasis; (6) method of treatment. Drawing from his personal cases he reviewed 84; 8 of these were inoperable, leaving 76 with all factors known after operation. The study was limited to five-year survivals.

Histologic grading was done according to the degree of differentiation: Grade 1, well differentiated, to Grade 3, poorly differentiated and showing considerable mitotic activity. Grade 1 showed 71 per cent survival; Grade 2, 39 per cent, and Grade 3, 25 per cent, the conclusion being that the survival rate diminishes with ascending histologic grade.

Macroscopic renal vein involvement is less common in the low-grade tumors and, when it occurs, it betokens a poor prognosis.

Lymph-node invasion is apparently unrelated to the histologic grade. The author feels that such invasion is an indication for postoperative x-ray therapy, to which the response is generally good.

Local extension into the perinephric fat, muscles, colon, and pancreas is more common in the higher grades and may be an indication for x-ray therapy before or after operation. If local extension is suspected, it may be confirmed by perirenal oxygen insufflation, and preoperative x-ray therapy may make a fixed tumor operable.

The author feels that occasionally nephrectomy is advisable in the presence of metastasis to relieve pain or hematuria, to control fever, or in the belief that resection of the primary tumor may make the metastases more susceptible to radiation therapy.

In the matter of treatment, the survival rate is believed to be higher in those who received postoperative x-ray therapy, the increase in salvage being higher in the high-grade lesions with renal vein involvement. Hence, x-ray therapy should be given when there is a high-grade tumor, renal vein involvement, lymph node invasion, or evidence of local extension. Surgical excision must be early and radical.

Seven tables.

F. J. MUNSON, M.D.
University of Pennsylvania

Malignant Neoplasms of the Kidney: An Analysis of 353 Patients Followed Five Years or More. R. H. Flocks and M. C. Kadesky. J. Urol. **79:** 196–201, February 1958. (University Hospitals, Iowa City, Iowa)

An analysis of 353 microscopically proved malignant neoplasms of the kidney is presented. The largest group consisted of 305 renal-cell carcinomas. The best results with these cases were obtained by x-ray therapy and subsequent nephrectomy. It is felt that, regardless of the extent of the disease at the time of diagnosis, some form of therapy should be instituted, as five- and ten-year survivals were considerably better in treated groups.

Thirty-one embryomas are included. The results of treatment are similar to those reported in other series, and it is pointed out that a two-year survival is not necessarily indicative of cure.

Seventeen tumors of the renal pelvis complete the series. All of these were treated by surgery alone. The results are similar to those previously reported.

One graph; 7 tables.

L. MURRAY HOUSER, M.D.
University of Pennsylvania

Irradiation of Carcinoma of the Bladder by a Central Intracavitary Radium or Cobalt 60 Source (The Walter Reed Technique). Milton Friedman and Lloyd G. Lewis. Am. J. Roentgenol. **79:** 6–31, January 1958. (M. F., 1016 Fifth Ave., New York 28, N. Y.)

The Walter Reed technic for treatment of cancer of the urinary bladder necessitates meticulous care and judgment in the application of eight basic principles: (1) classification of the lesion, (2) use of a small central source of radium or cobalt 60, (3) selection of an appropriate balloon applicator to irradiate the lower two-thirds of the bladder, (4) cystotomy inspection during each insertion of the radioactive source, (5) roentgenographic control of the applicator during treatment, (6) fractionation of the dose, (7) serial biopsies, and (8) selection of a suitable total dose, 6,000 to 10,000 gamma r, for each lesion.

A solid central source of radium or cobalt 60 is preferable to cobalt solution because of the high percentage depth dose, simplicity in preparation of the applicator, minimal exposure to the radiotherapist, absence of danger from breakage of the balloon, ease of rearrangement of position of the source with respect to the geometry of the lesion, ease of fractionation of the dosage, and the elimination of the burning effect on the bladder mucosa due to the beta radiation attendant upon cobalt solutions. Cystotomy is of the utmost importance in insuring proper placement of the radioactive source in

the position to irradiate the lesion most effectively. Careful control of the position of the source can be maintained through appropriate roentgenographic visualization technics throughout the treatment period.

The dose is fractionated as follows: (1) an initial treatment of approximately 1,000 gamma r per day at the surface of the balloon for four consecutive days, (2) an interval of five to seven days without treatment, (3) a second insertion of the radioactive source for an additional two to six days to complete a total dose of 6,000 to 10,000 gamma r. At the time of the second insertion of the source, direct visual observation of the lesion and serial biopsies must be carried out through the cystotomy opening. It is from study of the serial biopsy and the gross appearance of the tumor that the final total dose of radiation is determined.

Three reactions are of significance: (1) a foreign-body reaction to the balloon during treatment, (2) the usually transient radiation mucositis which occurs about one month after treatment, and (3) late dysuria and urinary frequency due to persistent infected ulceration or fibrotic contracture of the irradiated bladder.

In a series of 50 patients treated with this technic the absolute five-year apparent arrest rate was 56 per cent. Primary tumors yield better results than recurrent lesions.

Two weaknesses in the technic are: (1) a proneness toward recurrences in the dome of the bladder and (2) the possibility of abdominal wound implants during the cystotomy. Fortunately some of these recurrences may be arrested through surgery or fulguration. These weaknesses are thought to be minimal when compared with the ultimate high arrest rate seen in this method of treatment.

Thirty-four figures; 6 tables.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Management of Testicular Tumors. William J. Staubitz, Imre V. Magoss, Oscar J. Oberkircher, Melbourne H. Lent, Fred D. Mitchell, and Walter T. Murphy. J.A.M.A. **166:** 751–758, Feb. 15, 1958. (666 Elm St., Buffalo 3, N. Y.)

A series of 59 cases of testicular tumors is presented. The tumors were grouped as follows: seminomas, 22; embryonal carcinomas, 18; teratocarcinomas, 17; and choriocarcinomas, 2. Metastases to the para-aortic lymph nodes were found in 32 per cent and a total of 51 per cent of cases had metastases to para-aortic nodes and/or other sites. The seminomas were treated by orchiectomy and x-rays only. The remaining tumors were similarly treated, with the addition of retroperitoneal lymph node dissection if considered operable (on the basis of no radiologic or clinical evidence of widespread metastasis). Four-year follow-up showed 64 per cent of the seminoma patients and 41 per cent of patients with other testicular tumors living and well. Comparing their findings with a previous series (Sauer, Watson, and Burke: Surg. Gynec. & Obst. **86:** 591, 1948. Abst. in Radiology **52:** 617, 1949), the authors feel that the addition of retroperitoneal radical lymph node dissection improves the survival rate of embryonal carcinomas and teratocarcinomas.

One roentgenogram; 4 photomicrographs; 1 drawing; 5 tables.

CAPT. NEIL E. CROW, M.C.
Parks AFB, Calif.

A Study of Basic External Radiation Treatment Techniques with the Aid of Automatic Computing Machines. K. C. Tsien. Brit. J. Radiol. **31:** 32–40, January 1958. (Temple University Medical Center, Philadelphia, Penna.)

The author describes in great detail the system of determining multifield and rotational dose distribution in the planning of treatment, by means of punch cards and automatic computing machines. This system helps in ascertaining the complete dose distribution for each individual patient and system selected. It seems to be particularly useful for choosing the dose distribution for multifield therapy, whether this be partial or complete.

The recording of dose information on cards, the equipment required, and the procedure of operation are described. Basic field arrangements in multifield treatment, including two opposing fields and three oblique fields, are studied, leading to a discussion of the scope of these technics and the criteria for their use with various qualities of radiation, field sizes, and patient dimensions. Also, the calculation of dose distribution for moving fields, both in the plane of beam axis and along the axis of rotation, is discussed.

Thirteen figures; 1 table.

JULIAN O. SALIK, M.D.
Baltimore, Md.

RADIOISOTOPES

Localization Diagnosis with Radioisotopes. P. Doering. Schweiz. med. Wchnschr. **87:** 1037–1045, Aug. 10, 1957. (In German) (Medizinische Universitätsklinik Göttingen, Germany)

Diagnostic utilization of radioactive isotopes is based on the selective concentration of the isotope or of one of its compounds in the fluid, organ, or territory to be investigated. Scintillation and Geiger-Müller counting technics, and sometimes autoradiographs, are employed to trace the fate of the isotope introduced.

The *recognition of malignant neoplasms* is facilitated by metabolic alterations, especially of phosphorus-containing substances. This is why P^{32} was employed in the localization of tumors of the skin, breast, testes, prostate, urinary bladder, female genitals, bronchi, stomach, eye, and brain. Brain tumors were also studied with I^{131}-tagged di-iodo-fluorescein or albumin, as well as with Cu^{64}, As^{74}, and K^{42}. K^{42} has also been used for localizing breast tumors, Ga^{72} for bone tumors, and Au^{198} for liver tumors and for metastases from carcinoma of the breast. The most widely known application is the employment of I^{131} in tumors of the thyroid especially when combined with scintiscanning.

The *examination of nonneoplastic conditions* shows likewise that, numerically, I^{131} is the most frequently used isotope, because of its accepted position in the evaluation of thyroid function, but I^{131}-tagged compounds found utilization in diseases of the gallbladder (fluorescein, Biligrafin, Biliselectan), of the kidneys (Perabrodil, Diodrast), and even of the liver (rose bengal). For this last organ, Au^{198} has been used in a similar manner. P^{32} was employed for diagnostic stud-

ies of bone (fractures of the femoral neck) and the peripheral circulation, Na^{24} for heart function and for circulatory studies, and Fe^{59} and Xe^{133} for pulmonary function.

This interesting review includes 119 references taken from the international literature up to 1956.

Seven illustrations. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

A Method of Correction for Extrathyroidal Radioactivity. A. W. G. Goolden and J. R. Mallard. Brit. J. Radiol. **31:** 41–44, January 1958. (Hammersmith Hospital, London W. 12, England)

The authors describe their own method of correction for extrathyroidal radioactivity and refer to various other technics designed to correct for this activity. Their investigation was carried out on 10 totally thyroidectomized patients who had been maintained on thyroxin and were euthyroid at the time of the test. The investigation was designed to compare the change in radioactivity in a given volume of neck tissue with that in the same volume of thigh tissue. In principle the experiment was carried out with two scintillation counters, one on the neck and one on the thigh. Since the N/T ratio did not differ widely in the 10 individuals investigated, it was thought worthwhile to see whether it could be used as a routine method of correction for extrathyroidal activity in the measurement of early thyroid uptake. In 40 normal or hypothyroid patients it gave satisfactory results.

The authors have adopted the N/T ratio as a standard method of correction in order to obtain the absolute thyroid clearance rate for all groups of patients within thirty-five minutes of an intravenous injection of I^{131}. The plasma sample is taken at twenty-five minutes.

Four graphs; 1 table. JULIAN O. SALIK, M.D.
Baltimore, Md.

Radioactive Colloidal Chromic Phosphate to Control Pleural Effusion and Ascites. Melville L. Jacobs. J.A.M.A. **166:** 597–599, Feb. 8, 1958. (City of Hope Medical Center, Duarte, Calif.)

Forty-one patients with pleural effusions resulting from malignant disease in the chest were treated by instillation of 6 to 9 mc of radioactive colloidal chromic phosphate. Twenty-nine patients had only one instillation and the others two to four. The great majority had carcinoma of the lung or metastatic carcinoma of the breast. Sixty per cent were considered to have good results as manifested by suppression of fluid formation for a few to several months.

Sixteen patients with ascites (referable to carcinoma of the ovary in almost all instances) received instillations of 9 to 12 mc, usually in a single dose. One-third of these cases were considered to show good results.

Five brief case histories are presented to illustrate technic of injection, expected results, and pathologic changes determined at necropsy.

The point is made that radioactive colloidal chromic phosphate is much simpler to handle than is radioactive gold, and is safer and less expensive. It appears that the results are encouraging.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Measure of Erythropoiesis in Anemias. I. The Mixing Time and the Immediate Post-Transfusion Disappearance of T-1824 Dye and of Cr^{51}-Tagged Erythrocytes in Relation to Blood Volume Determination. Max M. Strumia, Louise S. Colwell, and Ann Dugan. Blood **13:** 128–145, February 1958. (Bryn Mawr Hospital, Bryn Mawr, Penna.)

Tagging of red cells with radioactive sodium chromate has become a preferred procedure for determination of the red cell mass and for the estimation of the survival of transfused red cells. The formulae which are generally applied for the calculation of these values from radioactivity data are as follows:

$$\text{Red Cell Volume} = \frac{\text{Total Red Cell Radioactivity Transfused}}{\text{"Immediate" Radioactivity/ml. of red cells}}$$

$$\text{Apparent Per Cent Survival of Red Cells} = \frac{\text{Radioactivity/ml. of Recipient's Red Cells at any time} \times 100}{\text{"Immediate" Radioactivity/ml. of red cells}}$$

A number of graphs are presented which show well the mixing time (*i.e.*, the interval after complete mixing of the labeled cells until the disappearance of any considerable number from circulation), the disappearance of injected dye (T-1824 or Evans blue), and the maximum concentration of the tagged cells in the blood. It is possible to divide all subjects into three groups: normal mixing, fast mixing, and slow mixing.

The following conclusions are reached:

1. The mixing time of transfused red cells and the mixing time of injected dye T-1824 occur within two minutes of each other in a given normal individual but vary considerably from individual to individual.

2. The decline in concentration of the injected dye after complete mixing also varies from one subject to another. In most normal individuals the maximal concentration of T-1824 dye occurs between two and three minutes postinjection. In this "normal" group, at ten minutes post-transfusion the decline in the dye concentration averages 3 per cent. In 8 per cent of normal individuals, the mixing is "rapid," and the dye concentration reaches the maximum within one minute and fifteen seconds. Thereafter, the dye concentration declines more rapidly, so that the loss at ten minutes postinjection averages 10 per cent. In the remaining 6 per cent normal individuals the mixing time is "slow," requiring nine to ten minutes.

Of 86 bed-patients, 50 per cent show the "rapid" mixing pattern.

The time of the injection of the tagged red cells and of the dye must be short, preferably between seven and ten seconds.

3. Multiple determinations of the concentration of tagged red cells and of dye T-1824 should be taken at short intervals immediately following injection, preferably at one, three, five and ten minutes post-transfusion. For the measure of the blood volume with the dye T-1824, the highest concentration is chosen; for the Cr^{51}-tagged red cell method, the "initial 100 per cent radioactivity" is obtained by an average of all values, from mixing time up to ten minutes post-transfusion, which fall within ± 3 per cent of the mean of all values. Special care in interpretation of results is required in individuals suffering from cardiac insufficiency.

4. Simultaneous determinations of the blood volume done with the Cr^{51}-hematocrit and dye T-1824-hemato-

crit procedures, applying the method of calculation here proposed, have resulted in variations of less than 5 per cent in 98 per cent of instances when compared with the "absolute" blood volume. In 80 per cent of the cases the variations were less than 3 per cent.

5. In the individuals who have a rapid mixing time, comprising 50 per cent of the bed-patients and 8 per cent of the normal population, calculation of the plasma and total blood volume by standard extrapolation method results in values 12.6 per cent higher than those obtained by the proposed method.

Ten graphs; 4 tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

The Effects of Acute Protein Depletion on the Distribution of Radioiron in Rat Tissues. W. F. Bethard, R. W. Wissler, J. S. Thompson, M. A. Schroeder, and M. J. Robson. Blood **13:** 146–155, February 1958. (Argonne National Laboratory, Lemont, Ill.)

Young adult Sprague-Dawley rats were divided randomly into two groups; one group was placed on a low-protein diet; the other on a high-protein diet. Thirty-five days after initiation of the diet 0.3 microcuries of Fe^{59} was given intravenously and the animals were sacrificed at various intervals thereafter. Aliquots of red cells, plasma, bone marrow, liver, and spleen were obtained, and Fe^{59} determinations were made. The possibility that polysaccharides might conjugate iron when protein was deficient was investigated by special technics.

The graphs clearly bring out the inability of the rats on the low-protein diet to make use of the available iron as contrasted to those receiving normal protein. In normal rats the usual metabolic pathways were used with consistent small amounts of iron in the liver and spleen. In the protein-deficient animals the time-concentration relationships were completely disrupted, with the iron storage playing the dominant role in the liver and, to a lesser extent, in the spleen. This iron was not conjugated with polysaccharide.

Five graphs; 2 tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

RADIATION EFFECTS—PROTECTION

Clinical Considerations Concerning the Origin and Therapy of Radiation Leukopenia. D. Schoen. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 12–24, January 1958. (In German) (Medizinische Strahleninstitut, Universität Tübingen, Tübingen, Germany)

Two clinical conditions predominantly limit the tolerance to radiation therapy: the skin erythema and leukopenia. The former seems about to be overcome by changing the physical factors of radiation. The problem of leukopenia was evaluated by observations on 461 patients treated with x-rays in the 220-kv range, ultrahard x-rays of 15.8 MEV, and fast electrons of 5 to 15 MEV. In all cases a tumor dose of 4,000 to 6,000 r was applied. A white cell count below 3,000 per cubic millimeter, occurring about one week after initiation of radiotherapy, was held to be consistent with leukopenia. An initial fall of leukocytes followed by a rise within twenty-four hours was considered a neuro-humoral stress reaction and was disregarded.

Of the 461 patients, 135 (29 per cent) showed leukopenia, beginning in the second week of treatment and persisting for eight to sixteen weeks. In a number of cases it lasted for six to seven months, and in 2 cases for five years. Restitution of the white cell count occurs usually four to eight weeks after termination of radiotherapy.

Leukopenia occurred after irradiation of the abdomen in 44 per cent of 152 cases, after irradiation of the thorax in 28 per cent of 231 cases, and after irradiation of the head and neck in 8 per cent of 65 cases; in none of 13 cases of peripheral irradiation was there a fall in the white cell count. These figures are favorably influenced by 40 cases treated with 15.8 MEV. These cases showed only a 20 per cent incidence of leukopenia.

In pelvic irradiation the tolerance volume dose was 30 to 35 megagramroentgens, in thoracic irradiation about 45 megagramroentgens. The tolerance of the left hemithorax is lower because the spleen is included in the scattering radiation. This results in leukopenia in 40 per cent of the cases, in contrast to 30 per cent following irradiation of the right hemithorax. In the latter cases the liver is included in the area of scatter.

The leukopenic effect appears to depend on the specific integral dose and the body weight. There is no difference when the grid method is used, provided the volume dose is the same. Previous irradiation predisposes to earlier and more severe leukopenia, suggesting sensitization to irradiation.

Protraction of irradiation, even with a one-day interval, results in "recuperation" of the white cells. Should this not occur, subsequent irradiation will be more depressive than in cases showing improvement in the leukocyte count.

Several cases treated with 200-kv x-rays alternating with 15.8 MEV x-rays showed a definite recuperation of the white cells after the high-voltage therapy. Irradiation with fast electrons caused leukopenia in only a few instances.

There was no correlation of sex, age, season, or subjective well-being with the degree of leukopenia. Erythropoiesis is independent of the degree of leukopenia.

In 3 cases which had received incompatible blood transfusions (M instead of N and Rh-positive instead of Rh-negative) autohemolysis was triggered by irradiation. This process reacted favorably to ACTH. Intercurrent infection diminished irradiation leukopenia. Vitamins proved ineffective. Estrogens were not tested, although they are reported to be effective. ACTH was found to be the most useful therapeutic agent.

Four figures; 3 tables. G. A. DOEHNER, M.D.
St. Vincent's Hospital, New York

Contribution to the Study of Pleuro-Pulmonary Lesions in Patients Irradiated for Breast Cancer. C. Rimondini and P. Gelmetti. Radiol. med., Milan **44:** 1–31, January 1958. (In Italian) (C. R., Sezione Radiologica dell'Istituto di Clinica Chirurgica Gen. e di Terapia Chir. dell' Università di Bologna, Italy)

Periodic chest roentgenograms are requested after irradiation for carcinoma of the breast so that metastatic activity can be ruled out. The diagnostic difficulties thus encountered are illustrated in this paper with 16 case reports selected from the "numerous" examples observed by the authors. Transient infiltrations

(fleeting pulmonary radiation reactions) are not easily differentiated from nonspecific (or even specific) inflammatory processes. Once they have disappeared, the problem becomes more or less academic. A different situation obtains with pulmonary fibrosis, which is a permanent result of irradiation. It will not disappear, and may lead to pulmonary "cirrhosis" with fibrothorax and pronounced retraction of the hemithorax, involving both lung and pleura.

Pulmonary metastases appear in one of the following forms: (1) multiple small nodules, (2) fewer large nodules (the so-called cannon-balls of English literature), (3) lobar infiltrations, (4) parenchymal extension from mediastinal and/or hilar lymph nodes, (5) the rare destructive type (parenchymal consolidation with subsequent excavation), (6) miliary carcinomatosis, and (7) carcinomatous lymphangitis (preferably called endolymphatic carcinosis, since there is no trace of an inflammatory process and hence no reason for the term lymphangitis). Confusion with pulmonary fibrosis is likely only in the last (seventh) type, but fibrosis is localized in the upper lobes (at the site or sites within the beam), while endolymphatic carcinosis usually exhibits at least a few nodular elements above and beyond the thin nodules resulting from superimposition (intersection) of two stripe-like opacities. Information regarding placement of the ports during irradiation, as well as the dosage and physical factors, is always of help. If everything else fails, follow-up examinations may always be suggested; the ultimate outcome should settle all the questions.

Thirty-nine roentgenograms.

E. R. N. GRIGG, M.D.
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Underdevelopment of the Female Breast Following X-Ray Irradiation in Childhood. Jaromir Kolář, Radko Vrabec, and Václav Bek. Strahlentherapie **104:** 596–599, December 1957. (In German) (Radiologischen Klinik der Karls-Universität, Prague, Czechoslovakia)

Variations in shape, size, and number of female breasts are often observed. The number of breasts is more often multiplied than decreased. In agenesis (a rather rare condition) not only the gland but also the areola and nipple are absent. In aplasia the gland is missing but the areola and nipple are present.

Variations in shape and size of the breasts are more frequent. A relatively rare cause for underdevelopment of the female breast is x-ray or radium irradiation for the treatment of pleural tumors or hilar tuberculosis. The authors report 4 observations of their own concerning such secondary phenomena after radiotherapy in childhood. In these 4 patients the mammary hypoplasia was a definite radiation sequel. In radiation therapy of the breast, as recommended by Haenisch, lead protection of the mammilla is not sufficient. Even with irradiation to the neighborhood of the gland, underdevelopment was observed.

The extreme radiosensitivity of the growing breast is in striking contrast to the relatively low sensitivity of the adult breast. Irradiation of the breast region, therefore, should be done only when vital indications demand it, since severe deformities may occasionally occur, nullifying the desired cosmetic effect, as in treatment of hemangioma.

Four photographs. HERBERT C. POLLACK, M.D.
Chicago, Ill.

Dose Measurements to Determine the Irradiation Danger in Deep X-ray Therapy in Infants. Hans Fetzer and Hans Ludwig Keller. Strahlentherapie **104:** 539–545, December 1957. (In German) (Universitäts-Kinderklinik München, Germany)

In irradiation therapy of infants and small children, the possibility of damage to the genital system must be taken into consideration because it is much closer to the treated area than in adults and therefore subject to stray radiation.

Quite frequently x-ray treatment has an excellent result in interstitial pneumonia of nurslings. In 2 such cases treated through an anterior chest portal measuring 10 × 10 cm., with a skin dose of 15 r at 50 cm. skin-target distance, under customary deep therapy conditions, dose measurements in the abdominal and dorsal regions in the median plane revealed a sharp radiation decline beyond the limits of the exposed portal. The dose on the abdominal wall at the level of the ovaries was 0.07 r, whereas the dose measured at the testes amounted to 0.02 r.

Irradiation of interstitial pneumonia in infants is justified, therefore, for three reasons: (*a*) The x-ray dosage to the testicles or ovaries is only a very small fraction of the dose considered permissible by the American Committee on Radiation Protection (10 r up to age thirty, in addition to cosmic rays). (*b*) The dose to the reproductive system lies within the normal range of diagnostic x-ray examinations. (*c*) x-ray treatment of interstitial infant pneumonia yields very favorable therapeutic results.

Four figures. HERBERT C. POLLACK, M.D.
Chicago, Ill.

Health Hazards in the Diagnostic Use of X-Ray. Paul C. Hodges. J.A.M.A. **166:** 577–584, Feb. 8, 1958. (950 E. 59th St., Chicago 37, Ill.)

The maximum permissible whole-body dose of ionizing irradiation is considered to be 300 mr per week or an accumulated dose of 210 r by age sixty. These figures, however, do not imply that there is specific knowledge as to the threshold leukemogenic dose, the quantitative relation of dosage to radiation-induced mutations, or other quantitative facts about radiation exposure with any degree of accuracy. Consequently, the author contends that any attempt to require a lifetime log of radiation dosage for everyone, as has been recently suggested, would be of questionable value, as well as involving enormous trouble and expense. In addition, there is the serious possibility that it would distract attention from more effective safeguards.

Everything possible should be done to reduce gonadal irradiation from diagnostic procedures through improved equipment and technics and reduction in the number of x-ray examinations performed when such reduction is consistent with good medical practice. However, evaluation of available data indicates that, with the possible exception of situations in which the gonads lie in the direct beam, diagnostic radiology conducted by qualified radiologists in the best types of offices and hospitals contributes an insignificant part of the total gonadal dose over a thirty-year period when compared to the contribution from existing background radiation.

The author considers in some detail current data as applied to the leukemogenic dose, genetic effects of radiation, background dosage, the fall-out problem, and dosage from clinical applications of x-rays. A number

of interesting comparative dose determinations from the various sources of radiation are presented.

Three illustrations; 2 tables.

CAPT. NEIL E. CROW, M.C.
Parks AFB, Calif.

The Delayed Effects of Ionizing Radiation. James V. Neel. J.A.M.A. **166:** 908–916, Feb. 22, 1958. (1133 E. Catherine St., Ann Arbor, Mich.)

The article is a very general and extensive one dealing with the problems and hazards of human exposure to ionizing radiations. The author reviews data from many sources and attempts to correlate the available information into a perspective from which members of the medical profession may view the problem. Much factual information is presented and is well worth study by those responsible for the utilization of ionizing radiations. A philosophical approach is adopted as the author attempts to point out the favorable as well as the unfavorable aspects of the exposure of large segments of the population to radiation. The very difficult problems inherent in an attempted calculation of genetic hazards are discussed.

"There can be no doubt in view of the evidence at hand that every effort must be made to minimize human exposure to irradiation. There is no doubt, on the other hand, that, in view of the directions in which our civilization is developing, some increase in radiation exposure over that provided by background sources is inevitable. It is a question of determining a reasonable price for the benefits, both direct and indirect, which accrue to the population as a result of exposure to that radiation."

A bibliography of important articles furnishing radiation data is attached.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Ionizing Radiation and Longevity of Physicians. Raymond Seltser and Philip E. Sartwell. J.A.M.A. **166:** 585–587, Feb. 8, 1958. (615 N. Wolfe St., Baltimore 5, Md.)

The authors feel that a recent article (Warren, S.: J.A.M.A. **162:** 464, 1956. Abst. in Radiology **69:** 159, 1957), pointing out that the average age at death of radiologists was found to be five years less than that of physicians who did not use x-rays routinely in the course of their practice should not be accepted uncritically.

Since radiology is one of the newest of medical specialties, there are proportionately fewer radiologists in the older age groups, in which the force of mortality is heaviest, when compared to the physician population in general. The expected age distribution at death is recalculated on this basis, utilizing data from 1940 and 1950. These calculations indicate that radiologists, on the average, would be expected to die at earlier ages because there are proportionately fewer elderly radiologists. The average age at death is shown to be misleading as an index of comparative longevity in groups having variable age composition and should not be utilized as an indication of long-term radiation effects.

A more valid study as to the impact of exposure to ionizing radiation upon longevity in the course of professional duties would be provided by a comparison of the age-specific death rates of radiologists and nonradiologists, each age group being followed in successive time intervals. Data for such a study are not now available.

CAPT. BRYON G. BROGDON, M.D.
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Influence on the Roentgen Effects of Simultaneous or Pre-Irradiation Respiration with Different Partial O_2 Pressures and Additional Fractionation Studies on Yoshida Tumors in Rats. Günther Grüssner. Strahlentherapie **104:** 514–523, December 1957. (In German) (Stadtkrankenhauses Kassel, Germany)

Experimental investigations were carried out on solid Yoshida tumors in rats in order to establish the irradiation effect under O_2 respiration when applied either simultaneously or before the x-ray irradiation. The following results were reported:

(1) An increase of the irradiation effect was observed when a partial O_2 pressure was used which was higher than that present in the air. When this pressure was elevated from 0.21 to 2.0 atmospheres, a marked intensification of the x-ray effect was noticed, which was further augmented by fractionation.

(2) This increase of the effect occurred with simultaneous O_2 respiration and also with previously administered oxygen as long as the interval between O_2 respiration and the onset of radiotherapy did not exceed five minutes.

(3) The tumor reduction observed depended on the initial size of the tumor and whether x-ray therapy alone or combined with O_2 respiration was applied. There is no striking difference between these two methods but only a gradual one. The larger the tumor the higher the radiation dose required combined with increased O_2 pressure and fractionation.

One photograph; 4 tables.

HERBERT C. POLLACK, M.D.
Chicago, Ill.

Optimal Fluoroscopic Kilovoltage with Respect to Secondary Radiation. G. Scarpa and G. Nori Bufalini. Radiol. med., Milan **43:** 790–794, August 1957. (In Italian) (Istituto di Radiologia dell'Università di Firenze, Italy)

The authors used a paraffin phantom, a diagnostic roentgen tube, a fluorescent screen, a photomultiplier tube, and a 0.25 r ionization chamber, to study the relationship between the kilovoltage and milliamperage employed and the amount of secondary radiation received by the operator during fluoroscopy. They found that, for a comparable brightness of the screen, a variation of the ma resulted in little or no change in the amount of secondary radiation, while an increase in kv—to achieve the same brightness with lesser ma—caused considerable reduction in the intensity of secondary radiation. Consequently, to the routine precautionary measures (shortest total fluoroscopic time, optimal dark adaptation, minimal screen brightness compatible with satisfactory vision, smallest adequate field, use of lead rubber gloves and gown) one may add the high-kilovoltage technic, *i.e.*, fluoroscopy at 90 kv or higher, especially for the abdomen. The inherent loss of contrast with high kilovoltage is practically negligible, while the use of additional filters (to safeguard the patient) does not increase the exposure to the fluoroscopist.

Seven diagrams.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Experimental Problems in Chemical Radioprotection. A. Herve and D. J. Mewissen. J. belge de radiol. **41:** 59–110, 1958. (In French) (A. H., Institut de Radiothérapie, Université de Liège, Belgium)

According to the old "target theory" of Crowther, the

biologic effect of ionizing radiation resulted from direct interaction between the energy absorbed and certain molecules of the affected cells. More recent concepts tend to interpose an "intermediate level" where ionizing radiations form "free radicals" with exceedingly high oxidative (or reducing) potentials. This was necessary to explain increased rates of mutation occurring after total body radiation with shielded gonads, in which case a so-called "transfer of energy" was assumed. The effectiveness of radioprotective substances is thus interpreted as a "neutralizing" action aimed at the "free radicals." A satisfactory radioprotective substance should not only be effective, but also of relatively low toxicity. The protective substance must be present in the body at the time of absorption of the radiation. If it were to be introduced later, it would no longer be considered protective, but rather therapeutic.

Many substances have been used under experimental conditions, as for instance (1) sodium cyanide (but not sulfocyanide) and sodium nitrate, both hopelessly toxic; (2) amines, among the most desirable being cystamine and especially cysteamine; (3) certain "anoxemia-producing" agents such as aminopropiophenone and carbon monoxide, (4) chelating agents (diethyldithiocarbamate), and (5) a heterogenous group, including phenobarbital, morphine, vitamin C, and certain carboxylic acids.

In this series, particular attention was devoted to cystamine and cysteamine, and both their qualitative and quantitative (relative, not absolute) effectiveness were demonstrated, not only by statistically significant longer survival rates of "protected" mice when compared with unprotected controls (irradiated with 250-kvp roentgen rays), but also by their influence on oral administration, against the effects of intraperitoneally injected radioactive P^{32}. Even local action could be obtained against segmentary irradiation.

Twenty-one diagrams; 7 tables.

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